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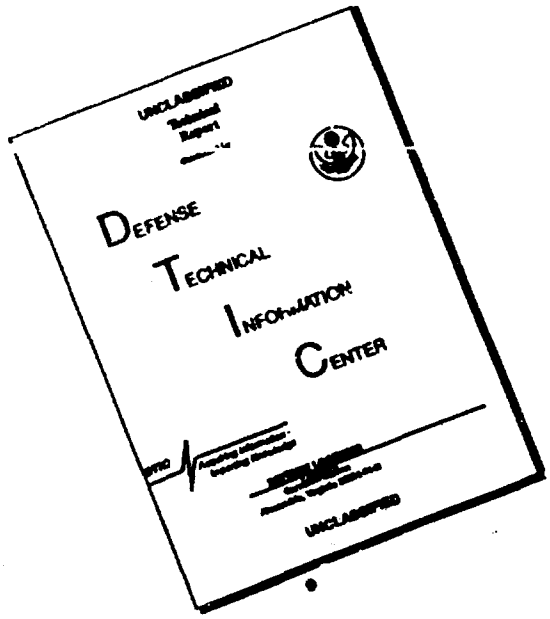


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# REPORT DOCUMENTATION PAGE

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11. EMERGENCY PLAN FOR FLOOD CONTROL PROJECT LAC QUI PARLE

12. PERSONAL AUTHOR(S)

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19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This plan implements the Corps program to prepare emergency plans for all Corps dams. It provides a guide for actions to identify and mitigate or respond to various types of emergencies which, while rare, could occur in the operation of the Lac qui Parle flood control project.

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Copies of the completed emergency plan for Lac qui Parle Dam, Marsh Lake Dam, and the Chippewa River Diversion are enclosed for your reference. This report implements the Corps program to prepare emergency plans for all Corps dams. It provides a guide for identifying, mitigating, or responding to various types of emergencies which, although unlikely, could occur during the operation of the dam.

Please contact me at (612)220-0429 with questions or comments or to request additional copies.

John F. Blackstone

JOHN F. BLACKSTONE
Project Manager

1 Encl
Emergency plan

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October 1988

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Mr. Vento/lj/353-2579
SUBJECT: Emergency Plans for the Lac Qui Parle Flood Control Project

DA, North Central Division, Corps of Engineers, 536 South Clark Street, Chicago, Illinois 60605-1592

1 MAR 1988

FOR: Commander, St. Paul District, ATTN: CENCS-ED-M

We have reviewed the subject emergency plan and find it to be generally acceptable. The plan is approved subject to preparing revised pages which provide updated personnel to be contacted and telephone numbers for the notification lists on pages A13-A15 and C14-C17.

FOR THE COMMANDER:

wd all encl

ZANE M. GOODWIN, P.E.
Chief, Engineering Division

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT, CORPS OF ENGINEERS
1135 U.S. POST OFFICE & CUSTOM HOUSE
ST PAUL, MINNESOTA 55101-1479

REPLY TO
ATTENTION OF

CENCS-ED-M (350-3-2A)

13 JAN 1988

MEMORANDUM FOR: Commander, North Central Division, 536 South Clark Street, Chicago, Illinois 60605-1592

SUBJECT: Emergency Plans for Lac qui Parle Flood Control Project

1. Subject reports are submitted in accordance with Engineer Regulation 1130-2-419.

2. These reports implement the Corps program to prepare emergency plans for all Corps dams. It provides a guide for identifying, mitigating, or responding to various types of emergencies, which, although unlikely, could occur during the operation of the Lac qui Parle Flood Control Project.

FOR THE COMMANDER:

Robert F. Post

1 Encl (2 cys)

ROBERT F. POST
Chief, Engineering Division

Some key contacts are not current but they will be corrected following your review. RFP

# EMERGENCY PLAN
# FOR
# LAC QUI PARLE FLOOD CONTROL PROJECT

Prepared by the
ST. PAUL DISTRICT
U.S. ARMY CORPS OF ENGINEERS

**OCTOBER 1988**

TABLES OF CONTENTS

LIST OF TABLES

## LIST OF PLATES



## APPENDICES

EMERGENCY PLAN
FOR
LAC QUI PARLE FLOOD CONTROL PROJECT

1. Introduction

The Lac qui Parle flood control project consists of three separate control structures: Lac qui Parle Dam, Marsh Lake Dam, and the Chippewa River Diversion Dam. Some of the land surrounding the Lac qui Parle Project that would be inundated by the probable maximum flood is not in Federal ownership. High water levels could cause a hazard to life and property in the vicinity of the reservoirs. In addition, large flows from the reservoirs during design floods could be hazardous to life and property in downstream areas.

a. Purpose

This plan implements the Corps program to prepare emergency plans for all Corps dams. It provides a guide for actions to identify and mitigate or respond to various types of emergencies which, while rare, could occur in the operation of the Lac qui Parle flood control project. Specific information on emergency actions to be taken is provided in the following appendices:

(1) APPENDIX A, Emergency Identification Subplan.

(2) APPENDIX B, Emergency Operations and Repair Subplan.

(3) APPENDIX C, Emergency Notification Subplan.

(4) APPENDIX D, Inundation Maps for Lac qui Parle Dam

(5) APPENDIX E, Inundation Maps for Marsh Lake Dam

(6) APPENDIX F, Inundation Maps for Chippewa Diversion Dam

b. Applicability

This emergency plan is applicable to all Corps elements and field offices concerned with the operation of the Lac qui Parle flood control project.

c. References

(1) Federal Guidelines for Dam Safety. Prepared by the Ad Hoc Interagency Committee on Dam Safety of the Federal Coordinating Council for Science, Engineering and Technology. Washington, D.C. June 25, 1979.

(2) DAEN-CWR-P letter dated 30 November 1979, Subject: Policy Issue No. 79-13, Corps' Role in Emergency Planning for Areas Downstream of Corps of Engineers Dams.

(3) ER 1130-2-417, Major Rehabilitation Program and Dam Safety Assurance Program (Revised Edition, 1980).

(4) ER 1130-2-419, Dam Operations Management Policy, dated 18 May 1978.

(5) ER 1110-2-101, Reporting of Evidence of Distress of Civil Works Project, dated 16 May 1968.

(6) ER 1105-2-40, Floodplain Management Services Program, dated 14 September 1979.

(7) ER 500-1-1, Emergency Employment of Army and Other Resources, Natural Disaster Procedures, dated 9 January 1978.

(8) DAEN-CWE letter dated 20 March 1978. Subject: Evacuation Plans for Areas Downstream of Corps Dams and Corps/State Cooperation on Safety Review of Corps Dams.

(9) Reconnaissance Report for Dam Safety Assurance Program, Lac qui Parle Flood Control Project, Minnesota River, Minnesota, September 1983.

(10) Lac qui Parle Reservoir and Minnesota River - Channel Improvement, Reservoir Regulation Manual, July 1966.

(11) Lac qui Parle Flood Control Project, Minnesota River, Minnesota, Marsh Lake Dam, Periodic Inspection No. 2, October 1978.

(12) Lac qui Parle Flood Control Project, Chippewa River, Minnesota, Bridge Over Chippewa River Control Structure on County Road No. 13, Chippewa County Periodic Inspection Report No. 4, October 1978.

(13) Lac qui Parle Flood Control Project, Chippewa River Diversion, Minnesota, Bridge Over Watson Sag Weir County Road No. 9, Chippewa County Bridge Inspection Report No. 5, October 1980.

(14) Lac qui Parle Dam, Minnesota River, Minnesota Dam, Bridge, and Earth Dike, Periodic Inspection Report No. 2, October 1974.

(15) Lac qui Parle Flood Control Project, Minnesota River, Minnesota, Marsh Lake Dam, Periodic Inspection Report No. 1, October 1975.

(16) Lac qui Parle Flood Control Project, Minnesota River, Minnesota, Bridge Over Lac qui Parle Control Structure, Inspection Report No. 2A, October 1978.

(17) Lac qui Parle Flood Control Project, Minnesota River, Minnesota, Lac qui Parle Dam and Bridge Periodic Inspection Report No. 3, September 1979.

(18) Lac qui Parle Dam and Bridge, Bridge Inspection Report No. 4, October 1980.

(19) Lac qui Parle Flood Control Project, Chippewa River, Minnesota, Bridge Over Chippewa River Control Structure on County Road No. 13, Chippewa County Bridge Inspection Report No. 5, October 1980.

(20) Inspection and Evaluation, Bridge Over Chippewa River Control Structure, County Road No. 13, Chippewa County, Minnesota, June 1974.

(21) Inspection and Evaluation, Bridge Over Watson Sag Weir, County Road No. 9, Chippewa County, Minnesota, June 1974.

(22) Inspection and Evaluation, Bridge Over Watson Sag Weir, County Road No. 9, Chippewa County, Minnesota, September 1976.

(23) Inspection and Evaluation, Bridge Over Chippewa River Control Structure, County Road No. 13, Chippewa County, Minnesota, September 1976.

(24) Lac qui Parle Flood Control Project, Chippewa River Diversion, Minnesota. Bridge Over Watson Sag Weir, County Road No. 9, Chippewa County. Periodic Inspection Report No. 4, October 1978.

(25) Definite Project for Construction of Lac qui Parle Flood Control Project, Minnesota, October 15, 1940.

(26) Earth Manual, Second Edition. U.S. Department of the Interior, Water and Power Resources Service Reprint - 1980.

(27) FM 5-34 Engineer Field Data, Department of the Army, 1976.

(28) FM 5-35 Engineer's Reference and Logistical Data, Department of the Army, 1971.

(29) Field Practices and Construction Methods for Flood Emergency, Department of the Army, Chicago District Corps of Engineers.

(30) EM 1110-2-1901, Soil Mechanics Design - Seepage Control, February 1952.

(31) TM 5-886-3, Subsurface Drainage Facilities - Emergency Construction, Departments of the Army and Air Force.

(32) Dam Failure Planning Report for Marsh Lake Dam, August, 1987.

(33) Dam Failure Planning Report for Chippewa Dam, September, 1987.

d. Scope

This plan addresses emergencies related to above normal reservoir water levels and/or rapid release of large volumes of water past the dams. It covers identification of impending or existing emergencies, notification of other parties concerning impending or existing emergencies, and emergency operations and repairs. Areas potentially affected by emergencies are identified for the cases of probable maximum flood without dam failure and probable maximum flood with dam failure.

e. Datum

All elevation readings contained in this report have the designation National Geodetic Vertical Datum (NGVD); 1929 mean sea level.

f. Definitions

(1) Pre-Emergency

A "Pre-Emergency" condition is one in which some impending or existing threat to the safe operation of the dam and reservoir is recognized but no significant hazard to life or property is expected to occur. Notification of other Corps offices is required upon declaration of a Pre-Emergency condition.

(2) Emergency

An "Emergency" condition is one in which the occurrence of a significant hazard to life or property is possible or certain to occur. Conditions justifying declaration of an Emergency condition may be imminent, such as breach of the dam or uncontrollable piping, or longer term, such as predicted large inflows. Warnings to evacuate are required upon declaration of an Emergency condition.

2. Description of Project Area

a. Location

The Lac qui Parle flood control project, which includes Marsh Lake, Lac qui Parle Lake, the Chippewa River Diversion, the Watson Sag Channel, and the Minnesota River between the head of Marsh Lake and Granite Falls, is located in west-central Minnesota near the South Dakota border. The project forms the northeastern boundary of Lac qui Parle County and the southwestern boundaries of Chippewa, Swift, and Big Stone Counties. The Lac qui Parle Dam is about 7 miles northwest of Montevideo, Minnesota, and 288.1 miles above the mouth of the Minnesota River. Marsh Lake Dam is farther upriver, approximately 303.5 miles above the mouth of the river. At normal or conservation pool level, the two impoundment from the two structures extends upstream to a point 27 miles above the Lac qui Parle Dam. The Chippewa Diversion Dam is located 11.9 river miles upstream from Montevideo, Minnesota on the Chippewa River. Flow diverted from the Chippewa River flows down the Watson Sag Channel entering the northeastern bay of Lac qui Parle Reservoir.

b. Topography

The project area is in the Minnesota River Valley, part of the prehistoric River Warren which drained the ancient glacial Lake Agassiz. The drainage area above the dams is aligned in a southeasterly direction following the course of the Minnesota River and traverses streams rapidly descending from the southern portion of the drainage area with drops of as much as 31 feet per mile. Streams traversing and draining the area north of the Minnesota River are divided by north-south morainal hills which rise less than 75 feet above the water courses.

Relief of the valley walls varies from 1,000 feet to 923 feet. Elevations of the flood plain vary from about 932 feet at Lac qui Parle Dam embankment to about 938 feet at the upstream reservoir limits of Marsh Dam.

c. Site Geology

Much of the State of Minnesota is covered by glacial deposits, and therefore much of the land surface consists of features derived from several different ice sheets that advanced across and retreated from the state. During the Pleistocene Epoch the state, with the exception of a small area in the extreme southwest corner, was covered during different periods by continental ice sheets. The debris left by these ice sheets covered the original landscape to depths ranging from 100 feet to over 400 feet. The glacial till in the area of the Lac qui Parle Project is made up principally of clays containing a noticeable amount of sand and gravel. The surface layer, about 2-feet thick, is composed of decayed vegetation that forms a rich black soil.

About 40 or 50 feet below the present drift a moraine of an earlier ice age, before the draining of glacial Lake Agassiz was completed, composed of granite, syenite and gneiss appears to generally underlie the project area. At an unknown distance below the moraine is the Archean bed rock of the landscape that existed prior to the formation of the glacial Lake Agassiz. At Marsh Lake Dam further evidence of glacial till was found during excavation of material in 1951 (Reference 15). Further geological information can be found in Reference 10.

d. Climate

The climate within and adjacent to the reservoir is variable. The area is subject to cold winters and warm summers, typical of continental conditions in the temperate zone. The mean annual precipitation over the basin is about 23.2 inches with about 76 percent falling during the months of April to September, inclusive. The mean annual temperature is about 44 degrees Fahrenheit with extremes ranging from -42 to 113 degrees Fahrenheit recorded. The climate is generally favorable for the diversified farming that is carried on in the area. The growing season is about 150 days.

e. Principal Streams

Lac qui Parle Dam and Reservoir has a drainage area above the dam of 4,050 square miles. The area of the reservoir (Lac qui Parle and Marsh Lakes) at the normal or conservation levels is about 18 square miles. The Chippewa River Diversion Dam has a drainage area above the dam of 2,050 square miles. When flow in the Chippewa River is less than 10 cfs then no water is diverted from the Chippewa River into the Watson Sag Channel. If the flow in the Chippewa River is larger than 10 cfs then a portion of the discharge in excess of 10 cfs is diverted into the

Watson Sag Channel. Discharge down the Chippewa River is maintained at 1000 cfs up to floods of about 5300 cfs. Above this discharge, the project is overtopped and no longer controls the diversion of flood waters.

In the upper northwest corner of the watershed, Big Stone Lake Reservoir is formed by a natural lake with a concrete dam at the outlet. Big Stone Lake and the Little Minnesota River which empties into the lake have a drainage area of 668 square miles. Big Stone Lake, at an altitude of 965 feet, occupies the upper end of a glacial gorge and is separated from Lake Traverse in the Red River of the North basin by the continental divide at an altitude of 980 feet. The outflow from Big Stone Lake forms the headwaters of the Minnesota River. The Whetstone River with a drainage area of 395 square miles entirely within South Dakota joins the Minnesota River just below the outlet of Big Stone Lake.

3. Description of Project Features

The existing project includes the following features: (a) the dam at the outlet of Lac qui Parle Lake; (b) the dam at the outlet of Marsh Lake; (c) the dam on the Chippewa River; (d) a diversion channel and weir for diverting water of the Chippewa River through the Watson Sag Channel into Lac qui Parle Lake; (e) alterations of highways, railroads, and bridges in the vicinity; and (f) improvement of the channel of the Minnesota River at various locations on the 43.1 miles between Lac qui Parle Dam and Granite Falls. Principal features of the project are shown on plates 1 through 6.

a. Lac qui Parle Dam

Lac qui Parle Dam, whcih carries a county highway across the Minnesota River, is the primary structure of this project. The dam has two central features, a control structure and an earth-filled embankment approximately 4,100 feet long. Capacity at conservation pool is 29,700 acre-feet while capacity at full pool is 122,800 acre-feet.

Control Structure

The control structure consists of a concrete curtain wall section and a fixed concrete spillway section. The curtain wall section is divided into four bays numbered 1 through 4, and the spillway section is divided into eight bays numbered 5 through 12. All the bays have a span of 17 feet, and the piers, which support a bridge over the control structure, are 3 feet wide. The deck elevation is 946.2.

Bays number 1, 3, and 4 each have two 6 x 8-foot vertical lift gates with sills at elevation 922.7. The stilling basin is at elevation 914.2 with a baffle wall top elevation of 920.2. Bay 2 has three 4 x 4-foot vertical lift gates with a sill elevation of 915.2. These gates are equipped with trash racks and are used for low flow regulation. These 9 moveable gates in the curtain wall section are numbered 1 through 9 beginning in bay number 1.

In the spillway section, the crest elevation is 934.2. In bays 5 through 7, the stilling basin elevation is 918.7. In bays 8 through 12, the stilling basin is at elevation 923.2, and these bays each have three sections of moveable steel bulkheads with top elevation of 940.7 when they are in the sealed position.

Earth Embankment

The earth embankment is approximately 4,100 feet long and includes an emergency spillway section. This section is capped with soil cement and a bituminous surfaced roadway. A concrete core wall is keyed 3 feet into natural ground at the upstream edge of the spillway. The downstream slope of the spillway is paved with 1 foot of grouted riprap on a 1 on 2 slope and has 6 feet of horizontal paving at the toe. The upstream slope is 1 on 3 and is seeded.

b. Marsh Lake Dam

This feature includes a dredged earth-fill dam in two sections totaling approximately 11,800 feet in length, a concrete spillway section 112 feet long, and a grouted riprap auxiliary overflow section 90 feet long adjacent to the concrete section. The earth fill has a top width of 10 feet and 1 on 3 side slopes except on the downstream side, where the 1 on 3 slope extends to 5 feet below the top of the dike. Below this elevation, the side slope changes to 1 on 4 natural ground. The maximum height of this dam is about 19.5 feet. The top elevation is mostly at 950.0, but varies between 948.6 and 952.6. The auxiliary spillway has a crest elevation of 940.0. The upstream and downstream slopes are both paved with 12 inches of grouted riprap. Capacity at conservation pool is 12,050 acre-feet while capacity at full pool is 35,000 acre-feet.

Marsh Lake Outlet Structure

The outlet structure is a concrete fixed-crest overflow section 112 feet long with a crest elevation of 937.6. Discharge goes first into a bucket type stilling basin at elevation 924.6,

then into the main discharge channel at elevation 929.6. The channel, which extends about 1,500 feet downstream from the spillway, has a bottom width of 25 feet and 1 on 2 side slopes, bounded on both sides by dikes having a top elevation of 938.0. When the water level is below the crest of the dam, the discharge is regulated by a 2-foot sluice gate in the main spillway which discharges through a 2-foot conduit into the stilling basin. The gate's sill is at elevation 932.6.

c. Chippewa River Diversion Dam

The Chippewa River Dam is the main structure for diverting a portion of the Chippewa River's floodwaters into the Lac qui Parle Reservoir. The dam is constructed of rolled earth fill and carries a 32-foot highway across the river at elevation 950.3. The dam, including the main control structure and a low-water control culvert, is about 1,900 feet long. Side slopes are 1 on 3 on the upstream side and 1 on 4 on the downstream side. There is an excavated revised approach with a 40-foot bottom width at elevation 932.8 and side slopes of 1 on 2.

The main control structure is a five-span combination highway bridge (Minnesota Department of Transportation Bridge No. 6389) and dam. The bridge is located about 1 mile north of Watson, Minnesota, on County Road 13. Built in 1938, the bridge is a reinforced concrete T-beam deck on reinforced concrete piers and abutments. The piers are founded on 12-inch round piles. There are five 30-foot center-to-center spans having a total length of 150 feet. The roadway has two traffic lanes and a total width of 23 feet between curbs. There are no sidewalks, and the total width between the concrete pedestals and iron pipe railing is 24 feet, 4 inches. The deck is surfaced with a bituminous overlay. The bridge receives light rural traffic and is rated for H-15 loading.

The control structure consists of a reinforced concrete modified ogee weir with baffle block energy dissipaters and a steel tainter gate. There are four 27-foot weir bays and one 27-foot tainter gate bay, a total of 135 feet of waterway opening. The distance between abutments is 147 feet. Bays 1, 2, 4, and 5 have a fixed crest spillway at elevation 942.3 ft. Discharge is onto a concrete apron (elevation 934.3) with a dentated end baffle. Bay 3 provides the discharge control by means of a 27-foot tainter gate. The top of the gate in the closed position is at elevation 942.3 ft. The sill elevation is 932.8. Discharge through the gate is onto a concrete apron at elevation 932.0 with an end baffle at elevation 932.8 ft. The tainter gate is powered by an electric power nut runner, but can also be operated by hand. About 300 feet west of the right abutment of the control structure is a low-water control culvert which was used prior to

the installation of the tainter gate in 1941. This culvert is a 4.0 x 4.0 x 90.4-foot concrete box type through the earth dike. The inlet is controlled by a 4.0 x 4.0 foot vertical lift gate protected by a trash rack. The entrance invert is at elevation 933.3 and the exit invert at 932.8. A 1,200-foot dike on the south bank of the approach channel acts as an extension of the dam and protects the railroad tracks adjacent to the channel from being flooded. The dike has a top width of 10 feet and side slopes of 1 on 3 on the channel side and 1 on 4 on the landward side. Elevation at the top of the dike varies from 946.3 to 947.8.

d. Chippewa River Diversion Channel and Weir

The excavated channel which diverts some of the floodwaters of the Chippewa River into the Lac qui Parle Reservoir is about 3,500 feet long with a bottom width of about 160 feet and side slopes of 1 on 3. The channel cuts through part of a natural ridge which separates the Chippewa River from the abandoned glacial channel known as the Watson Sag. A six-span combination highway bridge and spillway near the point of diversion controls the flood flows of the Chippewa River into the channel.

The crest of the spillway is at elevation 938.8 ft., and discharge is onto a concrete apron (elevation 932.3) with a dentated end baffle. The downstream channel bottom is at elevation 934.3 ft., and the upstream approach bottom is at 936.3. The bridge deck is at elevation 950.0 ft. When the stage in Lac qui Parle Reservoir is high enough and there are no flood flows coming down the Chippewa River, the flow in the diversion channel reverses and passes through the Chippewa River Dam and down the Chippewa River channel. Also, flows are maintained through the Watson Sag channel for fish and wildlife purposes as long as flows in the Chippewa River at the diversion are at least 10 cfs.

e. Minnesota River Channel Improvement

The Minnesota River channel was improved between Lac qui Parle Dam (mile 288.1) and Granite Falls, Minnesota (mile 245.0) by removing rocks and snags and constructing cutoffs at various locations to increase the bankfull capacity of the channel.

f. Public Use Areas

Day-use recreation facilities (consisting of picnic and parking areas and sanitary systems) are located at the dam sites. Also, participation in fishing, hunting, and nature study is quite extensive in the area. Waterfowl and upland game hunting

and sport fishing are of regional importance.

g. Instrumentation

Instrumentation related to the operation of the Lac qui Parle flood control project includes equipment to collect and monitor meteorological and hydraulic conditions and pool and tailwater stages.

The existing hydrologic network in and adjacent to the Minnesota River Basin consists of 82 climatological stations; 17 snow survey stations, 24 river discharge stations, of which five are miscellaneous discharge stations, and 41 river or reservoir stage stations. These stations have periods of record ranging from 1901 to the present. There are some 28 stations in the Minnesota River Basin that report precipitation amounts of .50 inch or more. Six precipitation stations are in or adjacent to the Lac qui Parle Reservoir basin. There are four stations adjacent to the reservoir that report precipitation at six hour intervals.

Sedimentation is not considered serious. Therefore, the plan for the systematic measurement of sediment deposits in the Lac qui Parle Reservoir has been abandoned.

Pool and tailwater gages are located at Lac qui Parle Dam, Chippewa River Dam and Marsh Lake Dam.

h. Operations and Maintenance

The Lac qui Parle flood control project is operated by the Corps of Engineers. Operation of the structure is supervised by the Water Control Center which is part of the Geotechnical, Hydraulics and Hydrologic Engineering Branch, Engineering Division of the St. Paul District Corps of Engineers. During normal periods of operation, instructions are issued to the park manager by phone or by radio (usually 3 telephone calls a week). During flood periods, daily contact is made with the park managers in order to issue operating instructions as conditions require and also to keep the District Office advised of conditions. The park manager informs the District

4. Potentially Affected Project Areas

The Lac qui Parle flood control project is located entirely on federally owned lands. An emergency situation could endanger the safety of people and property within these project borders. The principal areas are listed in the following subparagraphs.

a. Reservoir Surface

The reservoir surfaces are used heavily for boating, swimming and fishing. Lac qui Parle Reservoir extends approximately 15 miles upstream from the dam at normal pool elevation. The Marsh Lake Reservoir extends approximately 5 miles upstream from the dam at normal pool elevation.

Dangers to those on the reservoir surface as a result of an emergency could include strong surface currents in the event of a dambreak or flow over the spillway and strong wind action during storms. Weather conditions that accompany most large storms usually make recreation on the lake unlikely during such periods.

b. Recreation Areas

Day use recreation facilities are located at the damsites. Potential hazards at these areas due to an emergency affecting the dam and reservoir are minimal. The areas would be gradually inundated as the water surface rose.

5. Potentially Affected Non-Project Areas for Lac qui Parle Reservoir

Emergencies at Lac qui Parle Dam and Reservoir could pose significant hazards to life and cause extreme property damage as described in the paragraphs below.

a. Area Upstream of the Lac qui Parle Dam

Land within the area upstream of Lac qui Parle Dam is dominated by agricultural activity. The major threat to these areas is in the form of crop and other agricultural activities. In particular, Rosemoen Island, located approximately three miles upstream from the dam site and within the upstream federal project limits, would be totally inundated during the PMF.

b. Vicinity of the Lac qui Parle Reservoir

Land use within the area surrounding Lac qui Parle Reservoir is dominated by agricultural activity. The major threat to these areas is in the form of crop and other agricultural activities.

c. Area Downstream of the Lac qui Parle Dam

Results of the PMF reservoir routings for with and without failure conditions show that Lac qui Parle Dam would be overtopped in both cases. Routed flows for the without failure

overtopping condition result in a downstream profile which is slightly less than the with failure profile. The floodplain between the dam and downstream routing limit of Granite Falls, Minnesota, is a very wide, flat, rural agricultural area. Portions of the overbank are considered to be non-effective flow areas and provide potential for off-channel storage. In the town of Montevideo, a small area along the river would be affected during PMF conditions. The area inundated would include a few homes and buildings as well as a sewage disposal plant, pumping station, three parks, and the county fairground. The area would be subject to flood depths approximately .1 foot deeper under the dam failure condition compared to the without failure condition. Further downstream, the Spartan State Wildlife Management area would experience total inundation under PMF conditions. The area would be subject to flood depths approximately two feet deeper under the dam failure condition compared to the without failure condition. The town of Granite Falls, located approximately five miles downstream from the above state wildlife area, would be approximately 50% inundated under PMF conditions. The area inundated would include several major buildings of the town. The area would be subject to flood depths approximately 1.5 to 2 feet deeper under the dam failure condition compared to the without failure condition. The PMF wave travel time from the dam to Granite Falls is approximately 11 hours. Results of the with failure downstream routing show a peak outflow from the reservoir of 135,270 cfs which attenuates to 93,350 cfs at the downstream routing limit in Granite Falls. Maximum water surface elevations range from 946.1 below the dam to 891.6 below the Granite Falls Dam. Routings were terminated at Granite Falls at which point it was felt there was not a significant threat to loss of life further downstream.

6. Potentially Affected Non-Project Areas for Marsh Lake Dam

Emergencies at the Marsh Lake Dam and reservoir could also pose significant hazards to life and cause property damage.

a. Area Upstream of the Marsh Lake Dam

The area upstream of the Marsh Lake Dam is primarily wetland and agricultural in nature. Damage to crops and other agricultural activities is a major threat from a flood. Any residences in the inundated area would also be adversely affected by high flood waters.

b. Vicinity of Marsh Lake Reservoir

This area is also primarily wetland and agricultural in

usage. The major threat to these areas is in the form of crop and other agricultural activities.

c. Area Downstream of Marsh Lake Dam

Reservoir routings for the PMF event for both with and without failure conditions indicate that the dam would be overtopped in both cases. Downstream flooding elevations are about the same for the failure and non failure conditions. The area downstream of the Marsh Lake Dam has a very wide and flat floodplain. Approximately two miles downstream from the dam is Lac qui Parle Reservoir. The inundated land between the Marsh Lake Dam and Lac qui Parle Reservoir would affect residences and agricultural activities. Flooding elevations in this range from approximately 944 to 945 feet NGVD. Reservoir outflows for the PMF event are 109,000 cfs and 111,000 cfs for without failure and with failure conditions respectively.

7. Potentially Affected Non-Project Areas for Chippewa Diversion Dam

Emergencies at the Chippewa Diversion Dam could pose hazards to life and cause extreme property damage as described in the following paragraphs.

a. Area Upstream and in Vicinity of the Chippewa Diversion Dam

The area upstream and the area in the vicinity of the Chippewa Diversion Dam is not expected to undergo much damage from the PMF event. The reservoir is very small with little storage even during very large events. The land is primarily agricultural. Flooding may cause some damage to crops and other agricultural activities.

b. Area Downstream of the Chippewa Diversion Dam

The area downstream of the Chippewa Diversion Dam can experience significant flooding. The dam and reservoir have very little effect on large flooding effects. The PMF event with and without dam failure are nearly identical. The overbank areas of the Chippewa River are wide and relatively flat between the diversion dam and the town of Montevideo Minnesota. This area is primarily agricultural in nature with a few residences. The major damage would be to these residences and crops and other agricultural damage. The elevation of the flooding would range between 948.0 and 942.2 feet NGVD in this region. Floodwaters will cause significant damage near the town of Montevideo.

Maximum PMF discharges in this reach will be approximately 49,500 cfs. Low lying residential and commercial areas may experience significant damage during large flood events. PMF flood elevations in this region will be around 934.3 feet NGVD. Discharge rates past the town are expected to be around 49.500 cfs for the PMF. The Watson Sag channel through which Chippewa River flow is diverted will also be inundated by major events. The Watson Sag region is primarily wetland and agricultural in use. Damage would be done to crops and other agricultural activities.

8. Potential Causes of an Emergency

The potential causes of an emergency affecting the operation or safety of Lac qui Parle flood control project which were selected for planning include:

a. Earthquake

b. Failure Due to Mechanical Breakdown

c. Excess Seepage

d. Erosion

e. Sabotage

f. Extreme Storm

g. Slope Failure

Information and a brief discussion of each of the above items are discussed in the following paragraphs:

a. Earthquake

The possibility of an earthquake large enough to seriously affect the reservoirs and dams is not judged to be significant enough to warrant a detailed study. However, for further information, the following is included. According to Corps of Engineers Manual EM 1110-2-1902, Engineering and Design Stability of Earth and Rock Fill Dams, the project is in earthquake seismic zone 1. The chance of a significantly large earthquake appears improbable. However a 15 May 1909 earthquake in SE Saskatchewan of Intensity VI was in the IV/V range in this sparsely populated area. Another major midwestern continental basement fault is the Keeweenaw Fault which runs northeasterly into Canada, across Lake Superior and continues southwesterly across northern Wisconsin,

central Minnesota and dies out beneath the great plains in South Dakota. A historically inactive fault, it is a major tectonic feature, which if activated by the westward movement of the North American Continent could adversely affect this otherwise stable region. Minor earthquakes have occurred on this fault in the Lake Superior area possibly also due to continuing glacial rebound action.

b. Failure Due to Mechanical Breakdown

There are several types of situations related to errors in the operation of the dams and reservoirs that could occur. These include failure to operate the outlet gates properly and/or failure to use available instrumentation and data appropriately. Such situations could arise from the death, disablement or absence of the park manager, misreading or misinterpretation of data collected from instrumentation or simply from an operations error. These errors or failures if they were to occur would not result in sudden release of dangerous amounts of water past the dam because they can be corrected and/or controlled by prompt remedial action.

c. Excess Seepage

A potential exists for seepage through, around or under the dams. Some seepage is normal and not considered hazardous. However, seepage that increases in amount or contains suspended solids may indicate piping which can lead to breach of the dams. Seepage problems are potentially controllable depending on their severity, location and other circumstances.

d. Erosion

A potential exists for erosion downstream of the spillway stilling basins. Some amount of erosion is normal during floods and the channel gets back its normal cross section after the floods through the process of aggradation. However, excessive erosion due to major floods can lead to failure of the stilling basin and eventually damaging the dams if proper care and maintenance are not practiced. Normally, erosion problems can be controlled by normal inspections following a major flood event and proper maintenance. Erosion can also occur on the dike slope due to precipitation and wave action. If uncontrolled, it may lead to failure of the dike. Normal and routine inspection and maintenance can prevent failure of the dike due to this type of erosion.

e. Sabotage

A potential exists that operation of the dams could be

affected by sabotage disrupting communications, disabling gate controls or equipment, breaching the dam or various combinations of the foregoing. Only breaching of the dam, for instance by use of explosives, would cause sudden release of a dangerous volume of water.

f. Extreme Storm

An extreme storm could occur in the area of the reservoirs or over the watersheds upstream of the reservoirs. An extreme storm could result in large inflows, high reservoir levels, large discharges over the emergency spillways, and/or high waves on the reservoir surfaces. The potential for mitigating such problems depends on their severity and other circumstances.

g. Slope Failure

A sliding or sloughing of the dam faces could occur. A slope failure that extended to the top of the embankment would effectively lower the crest. This could result in sudden release of a large volume of water if the reservoir water surface exceeded the elevation of the resulting dam crest. The potential for control of slope failure problems depends on their magnitude, severity, reservoir water surface elevation and other circumstances.

## 9. Computation of Outflow Hydrographs for Lac qui Parle

Routing the probable maximum flood as presented in the Reconnaissance Report for Lac qui Parle Reservoir dated September 1983 through Lac qui Parle Reservoir under without failure conditions yielded a maximum pool elevation of 946.5 feet and maximum outflow of 106,500 cfs, with 0.5 foot of overtopping. Routing the PMF through Lac qui Parle Reservoir under with failure conditions yielded a maximum pool elevation of 946.2 and maximum outflow of 135,000 cfs, with 0.2 foot of overtopping. The PMF had a maximum peak inflow of 124,000 cfs. A routing of a normal high pool event with failure is discussed below.

a. Reservoir Routings

The PMF inflow hydrograph is shown on plate D-7 of Appendix D. The reservoir pool elevation hydrographs for PMF with and without failure are shown on Plate D-8 of Appendix D. Outflow hydrographs were computed for the hypothetical cases of PMF with and without dam failure as well as failure at normal high pool level. All outflow hydrographs were computed using the HEC-1 Dam

Break Model. The principal parameters of the respective computations for the PMF with and without dam failure are described in Table 1. These two cases along with failure at normal high pool level (elev. 937.5 ft.) encompass the types of situations potentially resulting from the causes of failure described in paragraph 8. Outflow hydrographs for the PMF with and without dam failure are shown on Plate D-9 of Appendix D. The starting pool elevation for the PMF routings is the conservation pool elevation of 931.2 feet. The normal high pool failure was assumed to begin with the pool at elevation 937.5 with a hypothetical inflow hydrograph which would result in the lowest possible releases from this reservoir stage. This combination of high pool and minimum releases was considered the most critical for this analysis. A time to failure of 3.0 hours and maximum breach width of 100 feet with vertical slopes were found to be a reasonable estimate of breach parameters. Failure of the earthen embankment adjacent to the gated structure was assumed with piping being the mode of failure.

TABLE 1
INFORMATION ON COMPUTATION OF OUTFLOW HYDROGRAPHS

LAC QUI PARLE DAM AND RESERVOIR

| | PMF without failure | PMF with failure | Failure at Normal High Pool Level |
|---|---|---|---|
| Initial Pool Elevation (ft) | 931.2 | 931.2 | 937.5 |
| Inflow Hydrograph | PMF | PMF | Normal |
| Breach Type | N/A | overtopping | piping |
| Pool Elevation when failure begins (ft) | N/A | 946.2 | 937.5 |
| Maximum Pool Elevation reached (ft) | 946.5 | 946.2 | 937.5 |
| Maximum Outflow (cfs) | 106,500 | 135,270 | 16,800 |
| Ultimate Bottom Width of Breach (ft) | N/A | 100.0 | 100.0 |
| Ultimate Bottom Elevation of Breach (ft) | N/A | 924.0 | 924.0 |
| Breach Shape (slope), (H:V) | N/A | 1:1 | Vertical |
| Time to develop (hrs) | N/A | 3.0 | 3.0 |

b. Comparison of Computed Peak Outflows

The computed maximum peak outflow for the case of PMF with failure is 135,000 cfs. This outflow is compared to outflows from known dam failures as shown in plate D-10 of Appendix D. The hydraulic depth of Lac qui Parle Dam, computed as the difference between the reservoir level at the completion of the breach (946.2 as shown on Plate D-8) and the invert elevation of the breach (924.0 as shown in Table 1), is approximately 22.2 feet. The value of the envelope curve shown on Plate D-10 for a hydraulic depth of 22.2 feet is approximately 23,000 cfs which is 112,000 cfs less than the maximum outflow computed for Lac qui Parle Dam. The difference is approximately 83% of the computed maximum outflow.

Several failure scenarios for Lac qui Parle Dam were studied. The case of failure concurrent with a PMF represents a compounding of extremely unlikely events. The case of failure at normal high pool level (elev. 937.5 ft.) represents much less severe conditions such as a piping failure that might occur under normal non-flood conditions. It is doubtful that the historical failure data (Plate D-10) contain events of the magnitude of the probable maximum flood at Lac qui Parle Dam. The envelope curve on that figure probably lies somewhere between failure at normal high pool level and failure at the probable maximum flood peak. For this reason, the computed result for the probable maximum flood with failure lies outside the historic envelope curve.

10. Routing of Outflow Hydrographs for Lac qui Parle Dam

Probable maximum flood reservoir outflows from Lac qui Parle Dam for with and without failure conditions were routed downstream using the dynamic routing techniques employed in the NWS Dambreak Program. Reservoir outflows from Lac qui Parle Dam for the condition of failure at normal high pool level (elev. 937.5 ft.) were routed downstream using HEC-1 normal depth channel routing procedures. In particular, the breach hydrograph under this condition had a peak outflow of 16,800 cfs. The limits of the channel routings were established at a point 24.5 miles downstream from the dam site and approximately two miles downstream from the town of Granite Falls, Minnesota. Additional computational procedures for routing outflow hydrographs downstream are described in the Reconnaissance Report for the Dam Safety Assurance Program referenced in paragraph 1-c.

a. Maximum Flood Elevations and Discharges

The computed maximum flood elevations for with dam failure and without dam failure conditions at each cross section between the dam and the town of Granite Falls with the time of occurrence are listed in Table 2. Locations of cross sections are shown on Plates D-2 through D-6 of Appendix D. For the condition of failure at normal high pool level, attenuation of the hydrograph through channel storage results in a peak discharge of 14,600 cfs at the downstream routing limit in Granite Falls. Peak stages at Granite Falls are about one foot over flood stage which will result in minor flooding in the low lying areas but will pose no serious threat. Stages in Montevideo will rise to about 3.4 feet above flood stage of 923.1 feet.

Five downstream crest profiles are shown on Plate D-11 of Appendix D. These profiles include PMF with and without failure, the historical flood event of 1969, failure at normal high pool and low water profiles. Discharge and stage hydrographs at Montevideo and Granite Falls for the condition of PMF with dam failure are shown on plates D-12 and D-13 respectively. Discharge and stage hydrographs at Montevideo for the condition of failure at normal high pool level are shown on plate D-14.

TABLE 2
COMPUTED ELEVATIONS AND PEAK FLOOD TIMES

LAC QUI PARLE DAM AND RESERVOIR

| Cross Section Number | River Mile | Distance from Dam (miles) | Probable Maximum Flood "Without Dam Failure" Peak Flood Time (hrs/min) | Probable Maximum Flood "Without Dam Failure" Peak Elevation (Feet above M.S.L.) | Probable Maximum Flood "With Dam Failure" Peak Flood Time (hrs/min) | Probable Maximum Flood "With Dam Failure" Peak Elevation (Feet above M.S.L.) |
|---|---|---|---|---|---|---|
| 4 | 285.3 | 2.8 | 37-00 | 945.2 | 4-00 | 946.1 |
| 9 | 278.9 | 9.2 | 39-00 | 944.1 | 5-00 | 944.2 |
| 11 | 277.9 | 10.2 | 39-30 | 944.1 | 5-30 | 944.2 |
| 12 | 276.7 | 11.4 | 40-00 | 944.1 | 6-00 | 944.1 |
| 14 | 273.3 | 14.8 | 42-00 | 939.3 | 8-00 | 941.2 |
| 15 | 271.3 | 16.8 | 44-00 | 935.0 | 9-00 | 936.8 |
| 17 | 268.1 | 20.0 | 47-00 | 925.9 | 10-30 | 927.5 |
| 18 | 266.4 | 21.7 | 48-00 | 917.3 | 11-15 | 919.3 |
| 19 | 265.9 | 22.2 | 48-00 | 913.5 | 11-15 | 915.1 |
| 20 | 265.6 | 22.5 | 48-00 | 904.6 | 11-15 | 906.1 |
| 23 | 263.6 | 24.5 | 49-00 | 890.0 | 12-00 | 891.6 |

1/ Elapsed time after assumed event until peak discharge occurs. For "without" failure conditions, elapsed time is measured from the time at which the reservoir level exceeds the top of the flood control pool. For failure conditions, elapsed time is measured from the beginning of failure.

2/ The computed maximum water surface elevation which would be reached at a location due to assumed conditions.

b. Occurrence of Hazardous Conditions

Hazardous conditions are defined as those in which:

(1) Floodwater depths are in excess of two feet.

(2) Floodwater velocities exceed four feet per second.

(3) Floodwater depths are sufficient to damage property.

The Minnesota River channel capacity below the dam of 1500 cfs is well below the 106,500 cfs being discharged through the dam at the peak of the PMF under the without failure condition. This large flow will result in substantial flows in the overbank areas. Due to the nature of the probable maximum flood, dangerously high flows will exist in the downstream reaches for a period exceeding 24 hours.

## 11. Computation of Outflow Hydrographs for Marsh Lake

The flood hydrograph of a probable maximum flood flowing through the reservoir without causing a dam failure causes a peak outflow rate of 109,000 cfs and a reservoir elevation of 952.0 feet NGVD. For the same event, under the condition of dam failure, the peak outflow would be 111,000 cfs with a maximum reservoir stage of 951.9 feet NGVD.

### a. Reservoir Routings

Plate E-2 of Appendix E shows the PMF inflow hydrograph. Plate E-3 of Appendix E shows the reservoir pool elevation hydrographs for the condition of the PMF with and without failure. Hypothetical cases of the PMF with and without dam failure as well as failure at normal high pool level were evaluated. Outflow hydrographs for these conditions were computed. The HEC-1 Model was used to compute all outflow hydrographs. Table 3 summarizes the principal parameters of respective computations for the PMF with and without dam failure. The two cases described above, along with failure at normal high pool level, (elev. 937.6 feet) encompass the types of situations potentially resulting from the causes of failure previously described. Plate E-4 of Appendix E shows the outflow hydrographs for the PMF with and without dam failure. The elevation of 937.6 ft. was assumed to be the starting pool elevation for the PMF

routings. The normal high pool failure was assumed to begin with the pool at elevation 937.6 feet with baseflow as inflow to the reservoir. The combination of high pool and minimum releases was considered the most critical for this analysis. Reasonable estimates of breach parameters included an instantaneous time to failure and maximum breach bottom width of 48.5 feet with 0.5:1 side slopes.

TABLE 3
INFORMATION ON COMPUTATION OF OUTFLOW HYDROGRAPHS

MARSH LAKE DAM AND RESERVOIR

| | PMF without failure | PMF with failure | Failure at Normal High Pool Level |
|---|---|---|---|
| Initial Pool Elevation (ft) | 937.6 | 937.6 | 937.6 |
| Inflow Hydrograph | PMF | PMF | Normal |
| Breach Type | N/A | overtopping | piping |
| Pool Elevation when failure begins (ft) | N/A | 951.9 | 937.6 |
| Maximum Pool Elevation reached (ft) | 952.0 | 951.9 | 937.6 |
| Maximum Outflow (cfs) | 109,000 | 122,000 | 1,900 |
| Ultimate Bottom Width of Breach (ft) | N/A | 58.5 | 58.5 |
| Ultimate Bottom Elevation of Breach (ft) | N/A | 933.1 | 933.1 |
| Breach Shape (slope), (H:V) | N/A | 0.5:1 | 0.5:1 |
| Time to develop (hrs) | N/A | 0.0 | 0.0 |

b. Comparison of Computed Peak Outflows

For the case of PMF with failure, the computed maximum peak outflow is 109,000 cfs. The hydraulic depth of Marsh Lake Dam, computed as the difference between the reservoir level at the completion of the breach and the invert elevation of the breach, is approximately 18.8 feet. The Marsh Lake discharge would plot very close to Lac qui Parle in Plate D-10. Plate D-10 shows that the value of the envelope curve for a hydraulic depth of 18.8 feet would be approximately 17,000 cfs. This discharge is approximately 92,000 cfs less than the maximum outflow computed for Marsh Lake Dam. The difference is approximately 84 % of the computed maximum outflow.

Marsh Lake Dam was evaluated under several failure scenarios. An extremely unlikely series of events would need to occur in order to cause dam failure under PMF conditions. The case of failure at normal high pool level represents a much less severe event caused by conditions such as a piping failure that might occur under normal non-flood conditions. It is unlikely that events of the magnitude of the PMF at Marsh Lake Dam would be contained in the historical failure data shown in Plate D-10. The envelope curve on that figure probably lies somewhere between failure at normal high pool level and failure at the probable maximum flood peak. Due to this fact, the computed result for the probable maximum flood with failure lies outside the historic envelope curve.

12. Routing of Outflow Hydrographs for Marsh Lake

Flood hydrographs were routed downstream using the HEC-1 normal depth channel routing procedure. The probable maximum flood breach hydrograph has a peak outflow of 111,000 cfs under this condition. The limit of the channel routing was located at a point 2.1 miles downstream from the site of the dam (within the pool of Lac qui Parle reservoir). The Dam Failure Planning Report for Marsh Lake Dam discusses additional computational procedures for routing outflow hydrographs downstream.

a. Maximum Flood Elevations and Discharges

The listing in Table 4 shows the computed maximum flood elevations for with dam failure and without dam failure conditions at each cross section between the dam and Lac qui Parle reservoir. Cross section locations are shown on Plate E-1 of Appendix E. For the condition of failure at normal high pool

level hydrograph attenuation attributable to channel storage results in a peak discharge of 1900 cfs at the downstream routing limit. Discharge and stage hydrographs at the dam for the condition of failure at normal pool are shown on Plate E-5 and E-6.

TABLE 4

COMPUTED ELEVATIONS AND PEAK FLOOD TIMES

MARSH LAKE DAM AND RESERVOIR

| Cross Section Number | River Mile | Distance from Dam (miles) | Probable Maximum Flood "Without Dam Failure" Peak Flood Time (hrs/min) | Probable Maximum Flood "Without Dam Failure" Peak Elevation (Feet above M.S.L.) | Probable Maximum Flood "With Dam Failure" Peak Flood Time (hrs/min) | Probable Maximum Flood "With Dam Failure" Peak Elevation (Feet above M.S.L.) |
|---|---|---|---|---|---|---|
| 1 | 305.0 | 2.1 | 50-00 | 944.3 | 1-45 | 944.4 |

1/ Elapsed time after assumed event until peak discharge occurs. For "without" failure conditions, elapsed time is measured from the time at which the reservoir level exceeds the top of the flood control pool. For failure conditions, elapsed time is measured from the beginning of failure.

2/ The computed maximum water surface elevation which would be reached at a location due to assumed conditions.

b. Occurrence of Hazardous Conditions

The channel capacity below the dam is well below the 109,000 cfs being discharged through the dam at the peak of the PMF under the without failure condition. As a result of the large flow, substantial flooding will occur in the overbank areas. Due to the nature of the probable maximum flood dangerously high flows will exist in the downstream reaches for greater than 24 hours.

13. Computation of Outflow Hydrographs for Chippewa Diversion

The flood hydrograph of a probable maximum flood flowing through the reservoir without causing a dam failure causes a peak outflow rate of 49,500 cfs down the Chippewa River channel with 49,000 cfs diverted down Watson Sag. A peak reservoir elevation of 954.2 feet NGVD was achieved for the probable maximum flood. For the same event with the condition of dam failure, the peak Chippewa River channel outflow would also be 49,500 cfs with a maximum reservoir stage of 954.2 feet NGVD. The similarity of flows and stages for the with and without failure conditions is due to the "run of the river" nature of the reservoir. The very small storage capacity of the reservoir results in inflows nearly identical to outflow for both cases.

a. Reservoir Routings

Hypothetical cases of the PMF with and without dam failure as well as failure at normal high pool level were evaluated. Outflow hydrographs for all of these conditions were computed. The HEC-1 Model was used to compute all outflow hydrographs. Table 5 summarizes the principal parameters of respective computations for the PMF with and without dam failure. The total outflow from the Chippewa Reservoir is released from the outlet works down the Chippewa River Channel and also over a diversion weir down the Watson Sag Channel to Lac qui Parle. Failure conditions have been modeled by using modified dam rating curves to reflect the failure opening in the dam. Additional information on these modeling techniques may be found in the Dam Failure Planning Report for Chippewa Dam. Plate F-3 of Appendix F shows the PMF inflow hydrograph. Plate F-4 of Appendix F shows the reservoir pool elevation hydrographs for the condition of the PMF with and without failure.

TABLE 5
INFORMATION ON COMPUTATION OF OUTFLOW HYDROGRAPHS

CHIPPEWA DIVERSION DAM AND RESERVOIR

| | PMF without failure | PMF with failure | Failure at Normal High Pool Level |
|---|---|---|---|
| Initial Pool Elevation (ft) | 940.0 | 940.0 | 940.0 |
| Inflow Hydrograph | PMF | PMF | Normal |
| Breach Type | N/A | overtopping | piping |
| Pool Elevation when failure begins (ft) | N/A | N/A | 944.0 |
| Maximum Pool Elevation reached (ft) | 954.2 | 954.2 | 944.0 |
| Maximum Outflow (cfs) | 49,500 | 49,500 | 2,700 |
| Ultimate Bottom Width of Breach (ft) | N/A | 69.9 | 69.9 |
| Ultimate Bottom Elevation of Breach (ft) | N/A | 933.6 | 933.6 |
| Breach Shape (slope), (H:V) | N/A | 1:1 | 1:1 |

The two cases described above, along with failure at normal high pool level, (elev. 944.0 feet) encompass the types of situations potentially resulting from the causes of failure described in paragraph 8. Because of the run of the river nature of the reservoir system, the with and without failure runs are almost identical. The elevation of 940.0 ft. was assumed to be the starting pool elevation for the PMF routings. The normal high pool failure was assumed to begin with the pool at elevation 940.0 feet with baseflow as the only inflow into the reservoir. The combination of high pool and minimum releases was considered the most critical for this analysis. Reasonable estimates of breach parameters included an instantaneous time to failure and a maximum breach bottom width of 69.9 feet with 1:1 side slopes.

b. Comparison of Computed Peak Outflows

For the case of PMF with failure, the computed maximum peak outflow for the Chippewa River channel and Watson Sag is 98,000 cfs. Plate D-10 of Appendix D shows this outflow in comparison to outflows from known dam failures. The hydraulic depth of Chippewa Diversion Dam, determined from a reservoir stage of 954.2 feet NGVD and the breach invert elevation of 933.6 feet, is approximately 20.6 feet. Plate D-10 shows that the value of the envelope curve for a hydraulic depth of 20.6 feet is approximately 20,000 cfs. This discharge is approximately 78,000 cfs less than the maximum outflow computed for Chippewa Diversion Dam. The difference is approximately 79.6 % of the computed maximum outflow.

Chippewa Diversion Dam was evaluated under several failure scenarios. An extremely unlikely series of events would need to occur in order to cause dam failure under PMF conditions. The case of failure at normal high pool level (elev. 944.0) represents much less severe conditions such as a piping failure that might occur under normal non-flood conditions. It is unlikely that events of the magnitude of the PMF at Chippewa Diversion Dam would be contained in the historical failure data shown in Plate D-10. The envelope curve on that figure probably lies somewhere between failure at normal high pool level and failure at the probable maximum flood peak. Due to this fact, the computed result for the probable maximum flood with failure lies outside the historic envelope curve.

## 14. Routing of Outflow Hydrographs for Chippewa Diversion

Flood hydrographs were routed downstream using the HEC-1 normal depth channel routing procedure. Stages were determined using an HEC-2 model of the Chippewa River Channel. The probable maximum flood breach hydrograph has a peak outflow of 49,000 cfs in the Chippewa River channel under this condition. The limit of the channel routing was located at a point 10.8 miles downstream from the site of the dam (at the town of Montevideo). The Dam Failure Planning Report for Chippewa Diversion Dam referenced in Paragraph 1-C discusses in greater depth the computational procedures for routing outflow hydrographs downstream.

### a. Maximum Flood Elevations and Discharges

The listing in Table 6 shows the computed maximum flood elevations for with dam failure and without dam failure conditions at each cross section between the dam and Montevideo. Cross section locations are shown on Plates F-1 and F-2 of Appendix F. For the condition of failure at normal high pool level, hydrograph attenuation attributable to channel storage results in a peak discharge of 2,700 cfs at the downstream routing limit. Discharge and stage hydrographs at the Chippewa dam for the condition of failure at normal high pool level are shown on plates F-5 and F-6 respectively.

TABLE 6
COMPUTED ELEVATIONS AND PEAK FLOOD TIMES
CHIPPEWA DIVERSION DAM AND RESERVOIR

| Cross Section Number | River Mile | Distance from Dam (miles) | Probable Maximum Flood "With and Without Dam Failure" Peak Flood Time (hrs/min) | Peak Elevation (Feet above M.S.L.) |
|---|---|---|---|---|
| 1 | 11.6 | 0.3 | 126-30 | 948.0 |
| 2 | 9.6 | 2.2 | 127-45 | 946.6 |
| 3 | 7.6 | 4.3 | 128-45 | 945.9 |
| 4 | 6.2 | 5.7 | 129-25 | 945.3 |
| 5 | 4.7 | 7.2 | 130-30 | 944.3 |
| 6 | 2.8 | 9.1 | 131-20 | 942.2 |
| 7 | 1.1 | 10.8 | 131-25 | 934.3 |

1/ Elapsed time after assumed event until peak discharge occurs. For "with" and "without" failure conditions, elapsed time is measured from the time at which the reservoir level exceeds the top of the flood control pool.

2/ The computed maximum water surface elevation which would be reached at a location due to assumed conditions.

b. Occurrence of Hazardous Conditions

The channel capacity below the dam is well below the 49,500 cfs being discharged through the dam at the peak of the PMF under the without failure condition. As a result of the large flow, substantial flooding will occur in the overbank areas. Due to the nature of the probable maximum flood dangerously high flows will exist in the downstream reaches for greater than 24 hours.

15. Inundation Maps

Plates D-2 through D-6 of Appendix D show the boundaries of the areas expected to be inundated by the probable maximum flood with and without dam failure at Lac qui Parle Dam. Plate E-1 of Appendix E shows identical information for Marsh Lake Dam and Plate F-1 and F-2 of Appendix F shows this information for the Chippewa Diversion Dam.

16. Affected Areas

Areas affected at Lac qui Parle Dam for the conditions of probable maximum flood with and without dam failure are indicated on Plates D-2 through D-6. Routed flows for the without failure condition indicate a downstream water surface profile that is for all practical purposes identical to the with failure water surface profile. Differences between the water surface profiles are so minimal that they cannot be shown on the inundation maps. Areas affected by the PMF event in the vicinity of the Marsh Lake Dam and Chippewa Diversion Dam can be seen in Plates E-1, F-1 and F-2.

Notes on the plates indicate any areas outside the inundation boundary which are potentially affected by secondary problems which might stem from inundation. The potential secondary problems noted on the plates for Lac qui Parle Dam, Marsh Lake Dam, and Chippewa Diversion Dam are listed in Tables 7, 8, and 9 respectively.

TABLE 7

POTENTIAL SECONDARY PROBLEMS STEMMING FROM INUNDATION
LAC QUI PARLE DAM AND RESERVOIR

| Plate(s) | Area | Potential Secondary Problem Affecting Area |
|---|---|---|
| D-4<br>D-5 | 1 | Inundated roads and bridges in the town of Montevideo, Minnesota will affect non-flooded areas by cutting off transportation into or out of the areas. Probable power failure and disruption of communication in the town of Montevideo, as a result of high flood flows, may also affect these outlying areas. |
| D-6 | 2 | Inundated roads and bridges in the town of Granite Falls, Minnesota will affect nonflooded areas by cutting off transportation into or out of the areas. Probable power failure and disruption of communication in the town of Granite Falls, as a result of high flood flows, may also affect these outlying areas. |

TABLE 8

POTENTIAL SECONDARY PROBLEMS STEMMING FROM INUNDATION
MARSH LAKE DAM AND RESERVOIR

| Plate(s) | Area | Potential Secondary Problem Affecting Area |
|---|---|---|
| D-4 | 1 | Inundated roads and bridges in the area will affect non-flooded areas by cutting off transportation into or out of the areas. Probable power failure and disruption of communication as a result of high flood flows, may also affect these outlying areas. |

TABLE 9

POTENTIAL SECONDARY PROBLEMS STEMMING FROM INUNDATION
CHIPPEWA DIVERSION DAM AND RESERVOIR

| Plate(s) | Area | Potential Secondary Problem Affecting Area |
|---|---|---|
| F-1 | 1 | Inundated roads and bridges in the area will affect non-flooded areas by cutting off transportation into or out of the areas. Probable power failure and disruption of communication as a result of high flood flows, may also affect these outlying areas. |
| F-2 | 1 | Inundated roads and bridges in the town of Montevideo, Minnesota will affect non-flooded areas by cutting off transportation into or out of the areas. Probable power failure and disruption of communication in the town of Montevideo, as a result of high flood flows, may also affect these outlying areas. |

17. Identification of Needed Evacuation Planning

a. Jurisdictions Affected

The area affected in the maximum case of the probable maximum flood with failure encompasses parts or all of the following jurisdictions in Lac qui Parle County, Chippewa County and Yellow Medicine County, all of which are located in Minnesota.

1. Montevideo, Minnesota
2. Granite Falls, Minnesota

b. Existing Evacuation Plans

Plans pertinent to dissemination of flood warnings and evacuation in the portions of the jurisdictions which would be affected in the case of the probable maximum flood with failure include:

[No plans were available. Evacuation plans are to be developed through local coordination with the affected communities.]

c. Evaluation of Existing Evacuation Plans

Principal characteristics of existing evacuation plans which affect their potential for successful execution are shown in Tables 10, 11, and 12 for the Lac qui Parle Dam, Marsh Lake Dam, and Chippewa Diversion Dam, respectively.

d. Needed Evacuation Planning

[Evacuation plans are to be developed through local coordination with the affected communities.]

TABLE 10

CHARACTERISTICS OF EXISTING EVACUATION PLANS
LAC QUI PARLE DAM AND RESERVOIR

| Plan Characteristic | Plan 1 | Plan 2 | Plan 3 |
|---|---|---|---|
| Is plan written? | NO | NO | NO |
| Is plan current? | | | |
| Does plan have formal legal status through appropriate adoption or recognition by non-federal authorities? | | | |
| Does plan specify actions to be taken in sufficient detail to avoid indecision on whether or not to execute the plan and how it should be executed? | | | |
| Does plan make specific assignments of responsibility for its initiation and execution? | NOT APPLICABLE - PLAN IS NOT WRITTEN AT THIS TIME. | | |
| Does plan cover all parts of the jurisdiction requiring evacuation? | | | |
| Is successful execution of plan in potential emergency situations reasonable in view of the warning time likely to be available for an emergency? | | | |
| Is plan consistent with various causes of emergencies likely to exist at time evacuation is required? | | | |
| Does plan evidence realistic analysis of means of warning and transporting evacuees, lane capacities of escape routes and other pertinent matters? | | | |
| Are equipment, personnel and materials required for execution of the plan identified? | | | |
| Does plan contain adequate provisions for updating, testing, practice and other maintenance activities to assure its continued viability? | | | |

TABLE 11

CHARACTERISTICS OF EXISTING EVACUATION PLANS
MARSH LAKE DAM AND RESERVOIR

| Plan Characteristic | Plan 1 | Plan 2 | Plan 3 |
|---|---|---|---|
| Is plan written? | NO | NO | NO |
| Is plan current? | | | |
| Does plan have formal legal status through appropriate adoption or recognition by non-federal authorities? | | | |
| Does plan specify actions to be taken in sufficient detail to avoid indecision on whether or not to execute the plan and how it should be executed? | | | |
| Does plan make specific assignments of responsibility for its initiation and execution? | NOT APPLICABLE - PLAN IS NOT WRITTEN AT THIS TIME. | | |
| Does plan cover all parts of the jurisdiction requiring evacuation? | | | |
| Is successful execution of plan in potential emergency situations reasonable in view of the warning time likely to be available for an emergency? | | | |
| Is plan consistent with various causes of emergencies likely to exist at time evacuation is required? | | | |
| Does plan evidence realistic analysis of means of warning and transporting evacuees, lane capacities of escape routes and other pertinent matters? | | | |
| Are equipment, personnel and materials required for execution of the plan identified? | | | |
| Does plan contain adequate provisions for updating, testing, practice and other maintenance activities to assure its continued viability? | | | |

TABLE 12

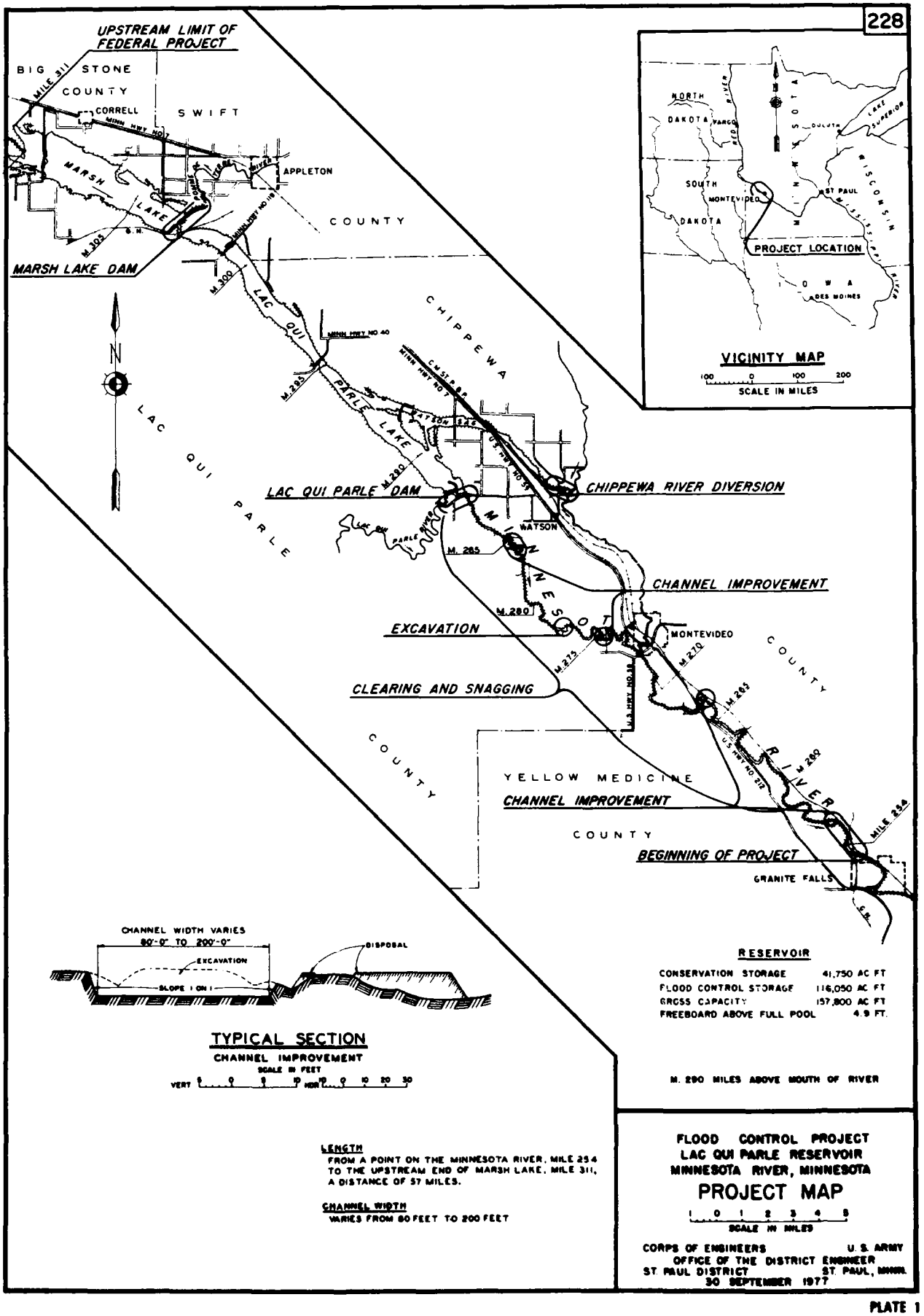
CHARACTERISTICS OF EXISTING EVACUATION PLANS
CHIPPEWA DIVERSION DAM AND RESERVOIR

| Plan Characteristic | Plan 1 | Plan 2 | Plan 3 |
|---|---|---|---|
| Is plan written? | NO | NO | NO |
| Is plan current? | | | |
| Does plan have formal legal status through appropriate adoption or recognition by non-federal authorities? | | | |
| Does plan specify actions to be taken in sufficient detail to avoid indecision on whether or not to execute the plan and how it should be executed? | | | |
| Does plan make specific assignments of responsibility for its initiation and execution? | NOT APPLICABLE - PLAN IS NOT WRITTEN AT THIS TIME. | | |
| Does plan cover all parts of the jurisdiction requiring evacuation? | | | |
| Is successful execution of plan in potential emergency situations reasonable in view of the warning time likely to be available for an emergency? | | | |
| Is plan consistent with various causes of emergencies likely to exist at time evacuation is required? | | | |
| Does plan evidence realistic analysis of means of warning and transporting evacuees, lane capacities of escape routes and other pertinent matters? | | | |
| Are equipment, personnel and materials required for execution of the plan identified? | | | |
| Does plan contain adequate provisions for updating, testing, practice and other maintenance activities to assure its continued viability? | | | |

CORPS OF ENGINEERS

U S ARMY

228







VICINITY MAP

100 0 100 200

SCALE IN MILES




TYPICAL SECTION

CHANNEL IMPROVEMENT

SCALE IN FEET

VERT 0 5 10 HOR 0 10 20 30

RESERVOIR

| | |
|---|---|
| CONSERVATION STORAGE | 41,750 AC FT |
| FLOOD CONTROL STORAGE | 116,050 AC FT |
| GROSS CAPACITY | 157,800 AC FT |
| FREEBOARD ABOVE FULL POOL | 4.9 FT. |

M. 290 MILES ABOVE MOUTH OF RIVER

LENGTH

FROM A POINT ON THE MINNESOTA RIVER, MILE 254 TO THE UPSTREAM END OF MARSH LAKE, MILE 311, A DISTANCE OF 57 MILES.

CHANNEL WIDTH

VARIES FROM 80 FEET TO 200 FEET

# FLOOD CONTROL PROJECT
# LAC QUI PARLE RESERVOIR
# MINNESOTA RIVER, MINNESOTA
# PROJECT MAP

1 0 1 2 3 4 5

SCALE IN MILES

CORPS OF ENGINEERS U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST. PAUL DISTRICT ST. PAUL, MINN.
30 SEPTEMBER 1977

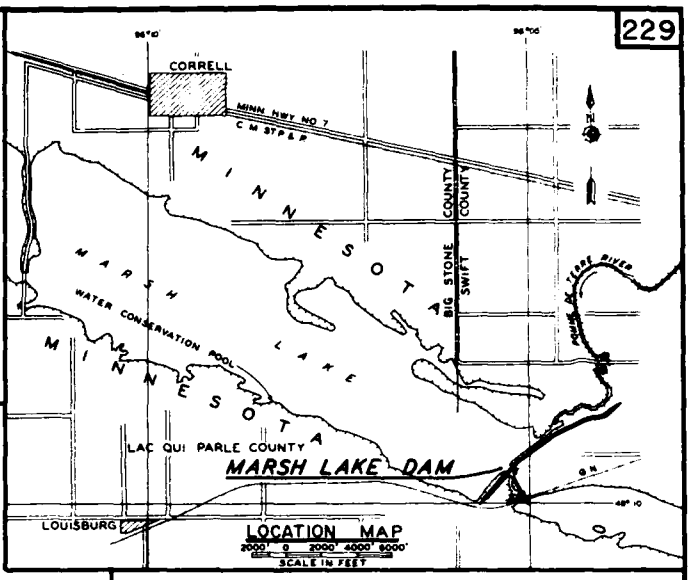
PLATE 1

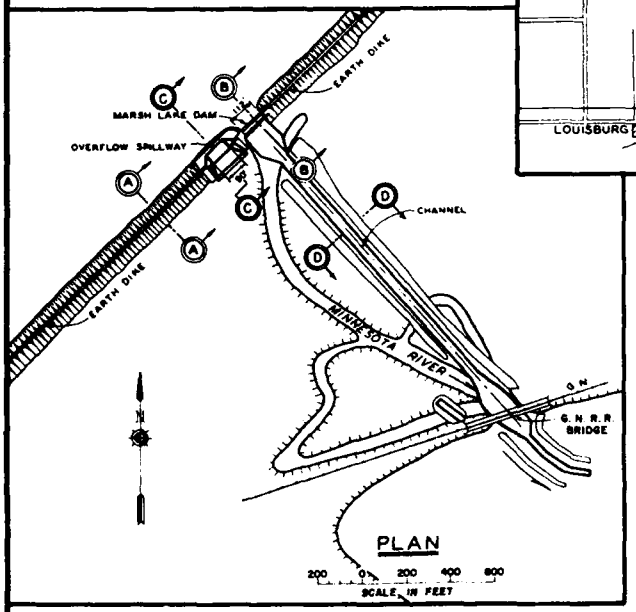
★ U.S. GOVERNMENT PRINTING OFFICE: 1984-75

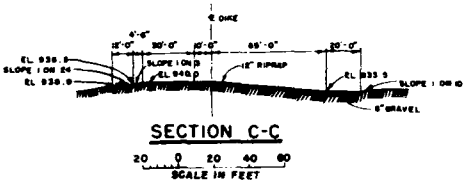
CORPS OF ENGINEERS

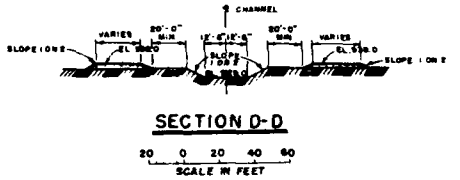
U. S. ARMY

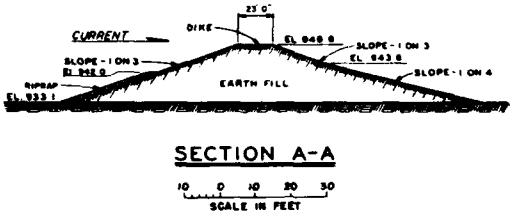
229

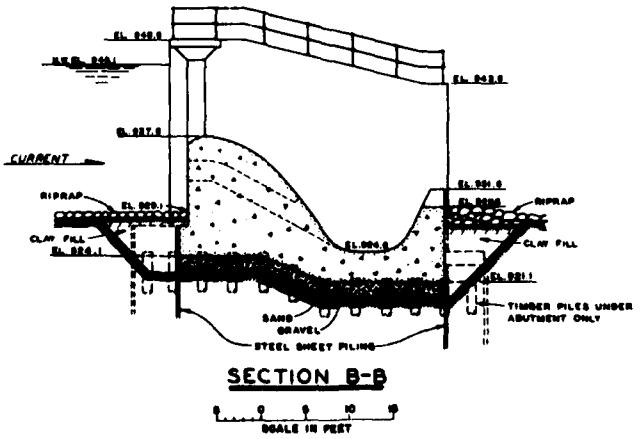



ELEVATIONS ARE REFERRED TO M. S. L. (1929 ADJ.)

FLOOD CONTROL PROJECT
LAC QUI PARLE RESERVOIR
MINNESOTA RIVER, MINNESOTA

# MARSH LAKE DAM

## PLAN & SECTIONS

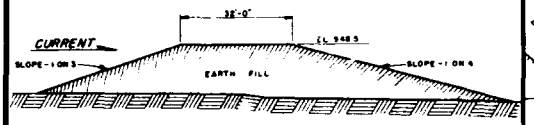
SCALE AS SHOWN

CORPS OF ENGINEERS — U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST. PAUL DISTRICT — ST. PAUL, MINN.
30 SEPTEMBER 1977

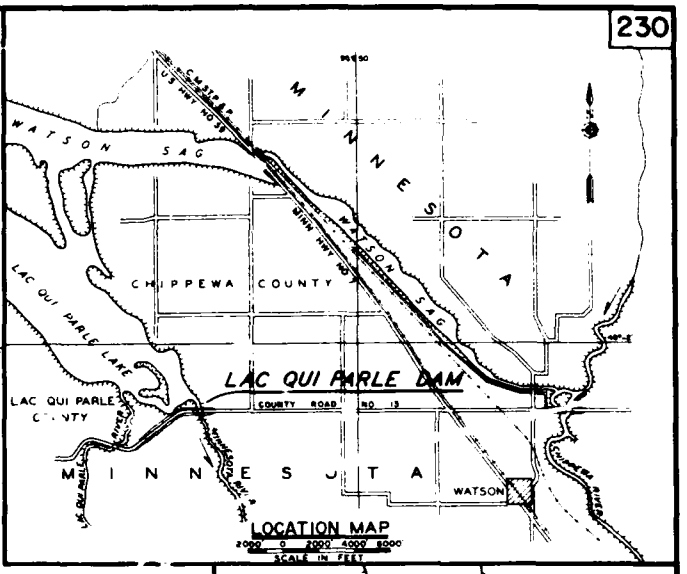
PLATE 2

★ U.S. GOVERNMENT PRINTING OFFICE: 1984-7

230

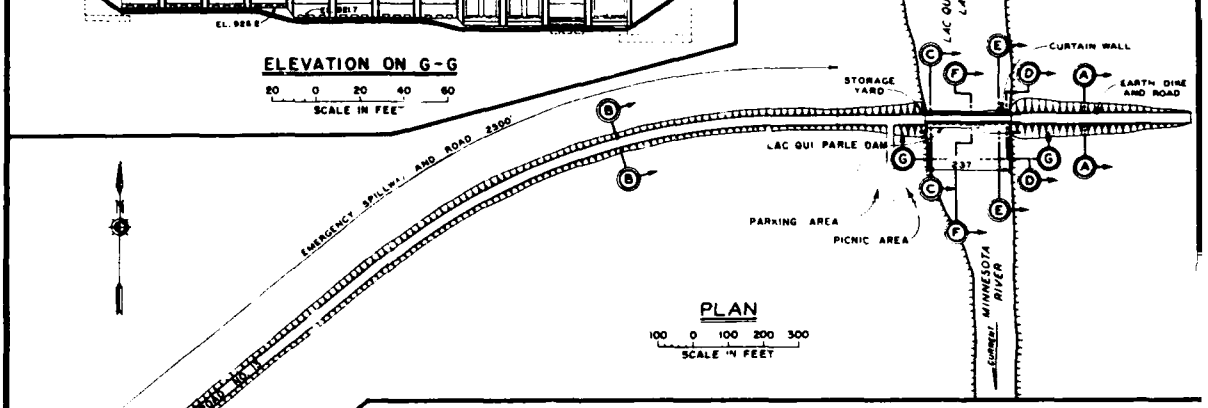



SECTION A-A
EARTH DIKE AND ROAD
SCALE IN FEET

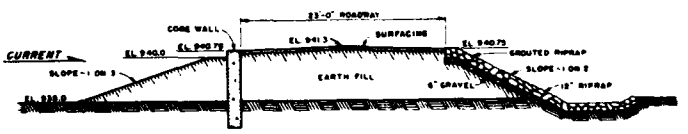



LOCATION MAP
SCALE IN FEET

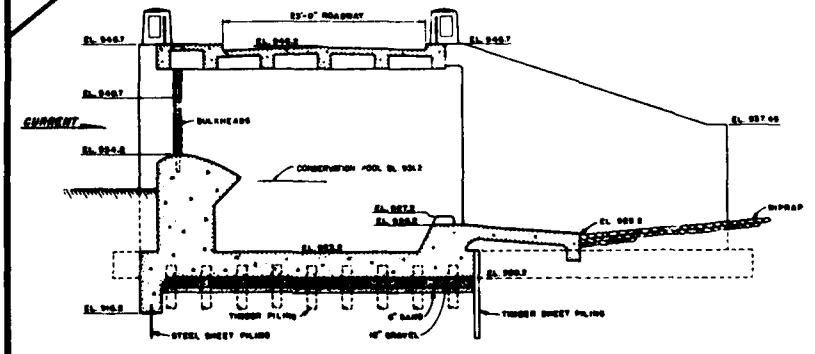
ELEVATION ON G-G
SCALE IN FEET




PLAN
SCALE IN FEET




SECTION B-B
EMERGENCY SPILLWAY
SCALE IN FEET




SECTION C-C
BAYS NOS. 1, 2, 3, 4 & 5
SCALE IN FEET

ELEVATIONS ARE REFERRED TO M.S.L. (1929 ADJ.).
FOR SECTIONS D-D, E-E & F-F SEE SHEET 231

FLOOD CONTROL PROJECT
LAC QUI PARLE RESERVOIR
MINNESOTA RIVER, MINN.

# LAC QUI PARLE DAM
## PLAN & SECTIONS

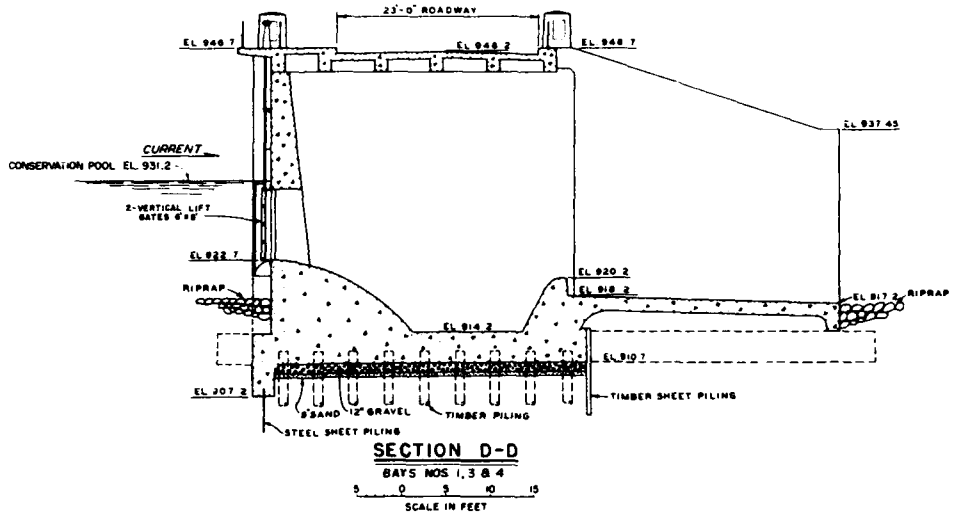
SCALE: AS SHOWN

CORPS OF ENGINEERS U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST. PAUL DISTRICT ST. PAUL, MINN.
30 SEPTEMBER 1977

PLATE

☆ U.S. GOVERNMENT PRINTING OFFICE: 198—

231

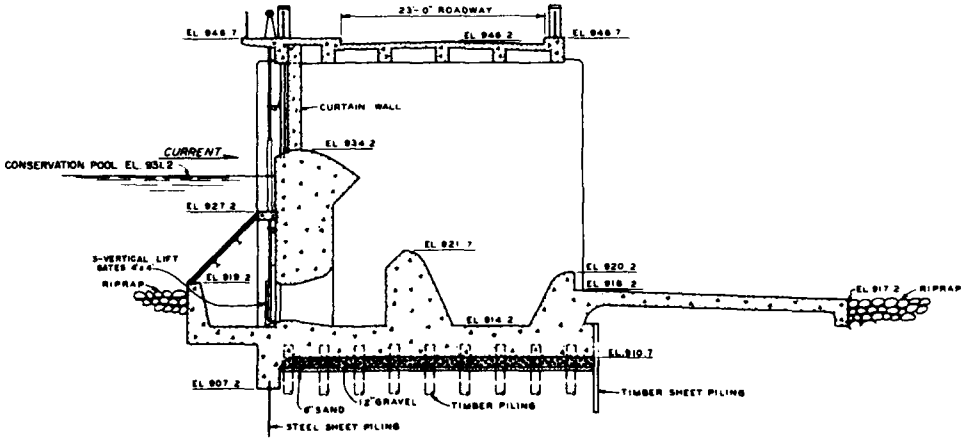



## SECTION D-D

BAYS NOS 1, 3 & 4

5 0 5 10 15

SCALE IN FEET

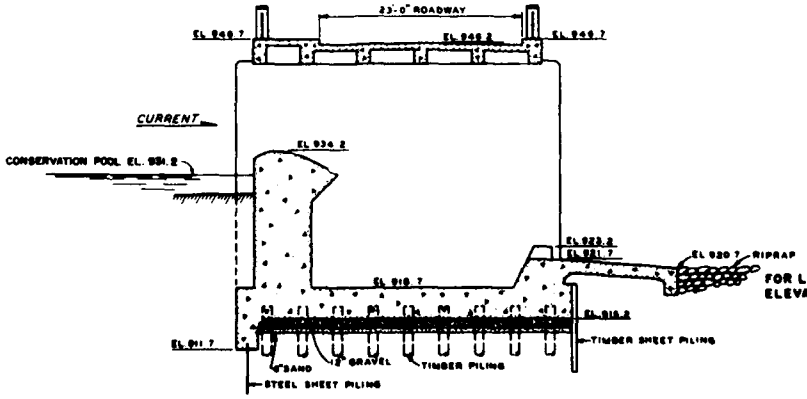



## SECTION E-E

BAY NO. 2

5 0 5 10 15

SCALE IN FEET




## SECTION F-F

BAYS NOS. 5, 6 & 7

5 0 5 10 15

SCALE IN FEET

FOR LOCATION OF SECTIONS SEE SHEET 230

ELEVATIONS ARE REFERRED TO M.S.L. (1929 ADJ.)

FLOOD CONTROL PROJECT
LAC QUI PARLE RESERVOIR
MINNESOTA RIVER, MINNESOTA

# LAC QUI PARLE DAM
# SECTIONS

SCALE AS SHOWN

CORPS OF ENGINEERS U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST. PAUL DISTRICT ST. PAUL, MINN.
30 SEPTEMBER 1977

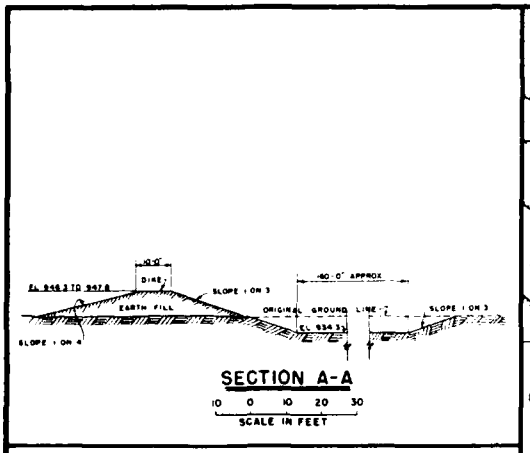
PLATE

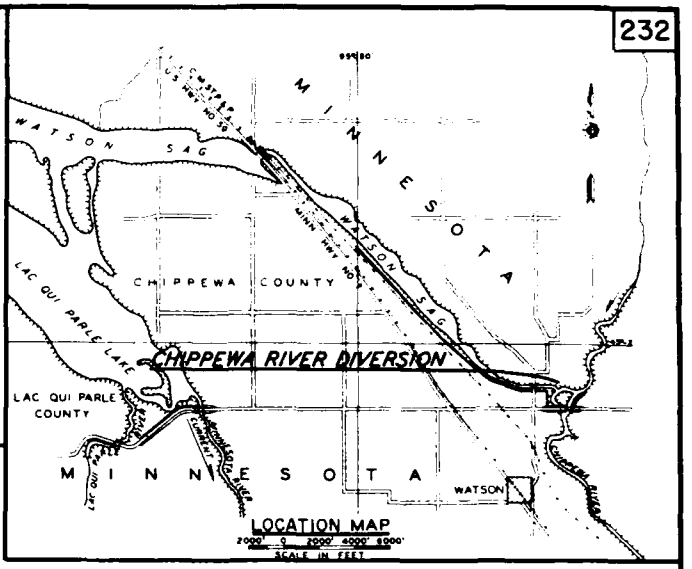
☆ U.S. GOVERNMENT PRINTING OFFICE: 1984

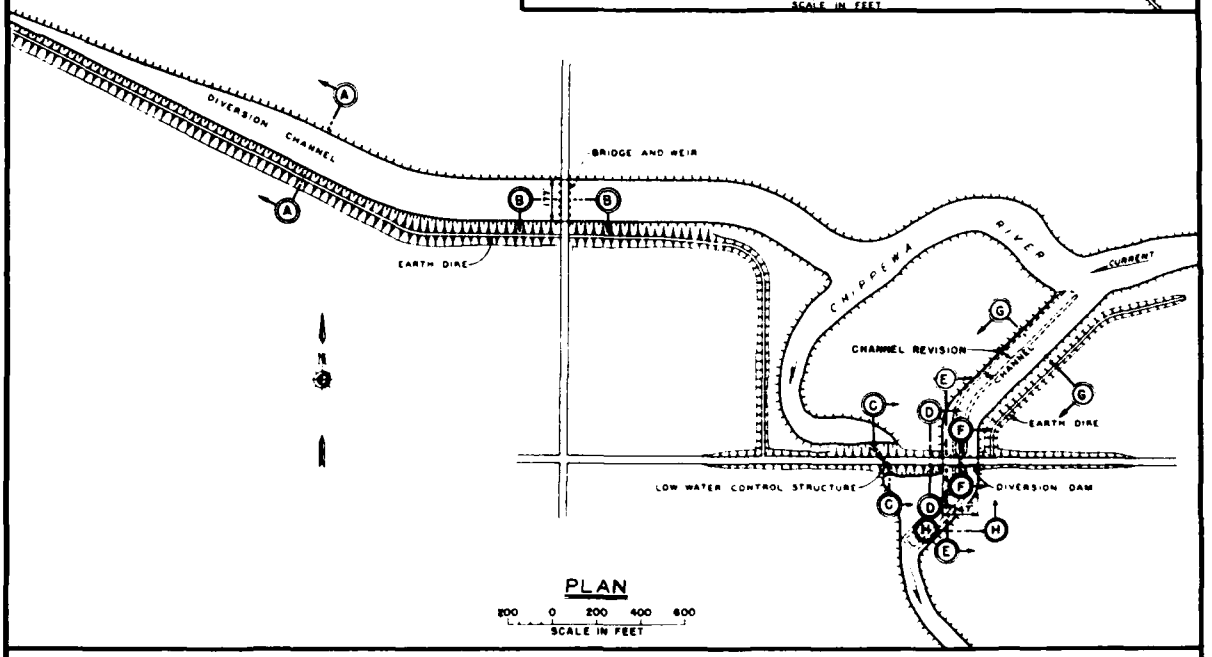
CORPS OF ENGINEERS

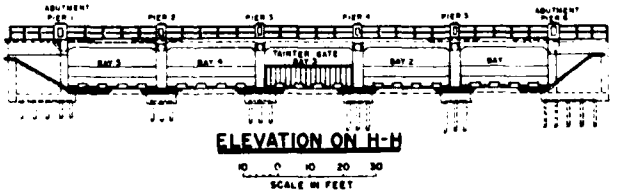
U S ARMY

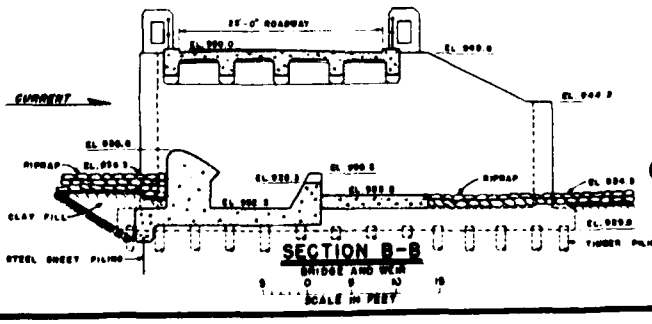
232




FOR SECTIONS C-C, D-D, E-E, F-F & G-G, SEE SHEET 233
ELEVATIONS ARE REFERRED TO M S L (1929 ADJ.)

FLOOD CONTROL PROJECT
LAC QUI PARLE RESERVOIR
MINNESOTA RIVER, MINNESOTA

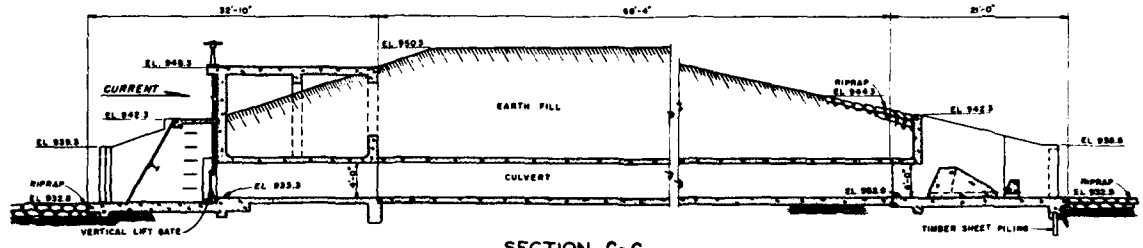
# CHIPPEWA RIVER DIVERSION
## PLAN AND SECTIONS

SCALE AS SHOWN

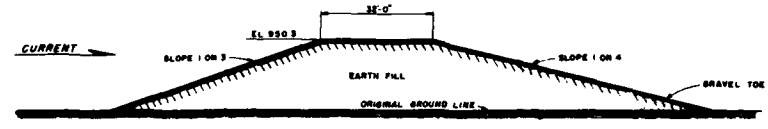
CORPS OF ENGINEERS U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST. PAUL DISTRICT ST. PAUL, MINN.
30 SEPTEMBER 1977

PLATE 5

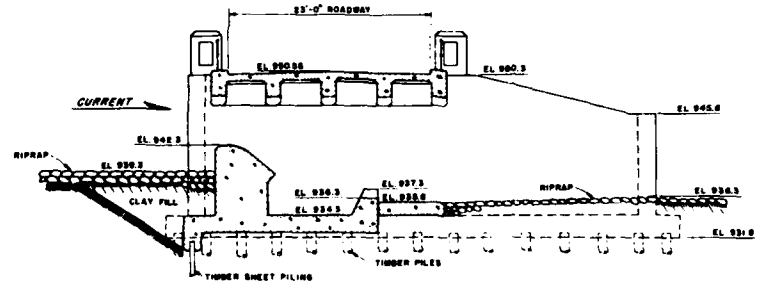
233



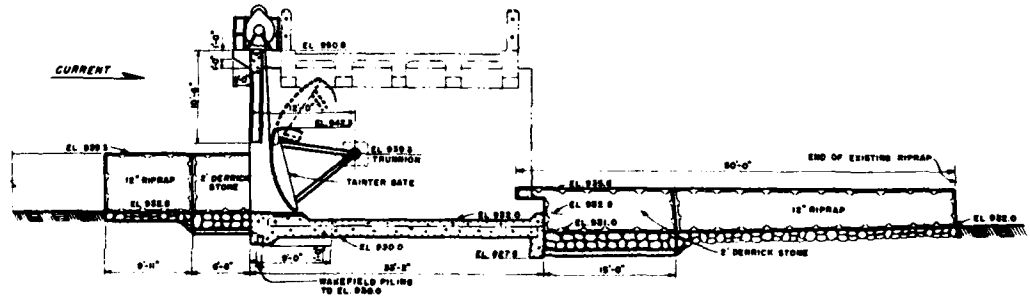

## SECTION C-C
LOW WATER CONTROL STRUCTURE
SCALE IN FEET



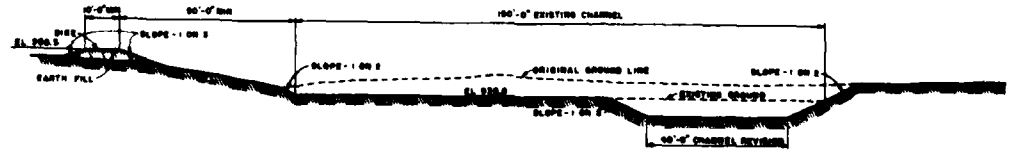

## SECTION D-D
SCALE IN FEET




## SECTION E-E
DIVERSION DAM
SCALE IN FEET




## SECTION F-F
SCALE IN FEET




## SECTION G-G
CHANNEL AND DIKE
SCALE IN FEET

NOTE:
FOR LOCATION OF SECTIONS SEE SHEET 232
ELEVATIONS ARE REFERRED TO M.S.L. (1929 ADJ.)

FLOOD CONTROL PROJECT
LAC QUI PARLE RESERVOIR
MINNESOTA RIVER, MINNESOTA

# CHIPPEWA RIVER DIVERSION
## SECTIONS

SCALE: AS SHOWN

CORPS OF ENGINEERS U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST. PAUL DISTRICT ST. PAUL, MINN.
30 SEPTEMBER 1977

PLATE 8

# EMERGENCY IDENTIFICATION SUBPLAN

## APPENDIX A

to

## EMERGENCY PLAN

for

## LAC QUI PARLE FLOOD CONTROL PROJECT

OCTOBER 1988

## TABLE OF CONTENTS



## LIST OF TABLES

EMERGENCY IDENTIFICATION SUBPLAN
LAC QUI PARLE FLOOD CONTROL PROJECT

A-1. Introduction

Conditions affecting operation of Lac qui Parle flood control project could result in a hazard to life and/or property due to high reservoir levels and/or sudden release of large volumes of water. Early identification of the existence or potential for occurrence of such conditions is essential as a basis for initiating emergency operations and/or repairs and for issuing appropriate notifications to higher authority and potentially affected parties.

a. Purpose

This subplan implements a portion of the Corps program to prepare emergency plans for all Corps dams. It establishes procedures for identifying impending and existing emergencies affecting the operation and safety of Lac qui Parle flood control project.

b. Scope

This subplan deals with identification of impending or existing emergencies related to operation error, excess seepage, foundation failure, abutment failure, slope failure, erosion, threatened sabotage/sabotage, extreme storm, and upstream dam failure. Instructions are included concerning:

(1) Monitoring and reporting of conditions.

(a) Routine - during duty hours. Monday thru Friday (0800-1630).

(b) Non-routine - on a 24 hr. basis or as directed by District Office. Additional personnel may be required at discretion of Western Flood Control Office.

(2) Communications between the project office, St. Paul District Office, and Western Flood Control Project Office.

(3) Criteria for action including declaration of a Pre-Emergency or Emergency condition and activation of the Notification Subplan and/or Emergency Operations and Repair Subplan.

c. Applicability

This subplan is applicable to all Corps elements and field offices concerned with operation of Lac qui Parle flood control project.

A-2. Definitions

a. Pre-Emergency

A "Pre-Emergency" condition is one in which some impending or existing threat to the safe operation of the dam or reservoir is identified but no significant hazard to life or property is expected to occur. Declaration of a Pre-Emergency condition is internal to the Corps of Engineers and does not require notification of other parties or warnings to evacuate.

b. Emergency

An "Emergency" condition is one in which the occurrence of a significant hazard to life and/or property is possible or certain to occur. Conditions justifying declaration of an Emergency condition may be imminent or longer term. Declaration of an Emergency condition requires notification to key personnel and issuance of warnings to evacuate potentially hazardous areas.

c. Park Manager

The term "Park Manager" means the individual in charge at the Lac qui Parle flood control project.

d. Western Flood Control Project Office

The term "Western Flood Control Project Office" means the person in charge of the Western Flood Control Project Office.

e. District

The term "District" means one of the following elements depending upon which is appropriate for the situation at hand.

(1) Dam Safety Officer. The Dam Safety Officer must be kept informed of all pre-emergency or emergency situations. Responsible for identifying and/or providng the necessary engineering or technical support required for the pre-emergency or emergency situation. Also responsible for keeping the Dam Safety Committee, and the NCD Dam Safetty Officer informed of the pre-emergency or emergency situation.

(2) Project Operations Branch. Responsible for identifying a person-in-charge of the pre-emergency or emergency situation. Responsible for keeping the Dam Safety Officer informed of the pre-emergency or emergency situation. Also, responsible for matters involving normal dam operations, and/or other matters not covered by the other District elements.

(3) Emergency Operations Center. Provides a 24-hour telephone contact with the District Office. Responsible for keeping the Dam Safety Officer, the Commander/District Engineer, and NCD in contact with the operations and personnel. Also responsible for matters involving national security, disasters, and mobilization.

(4) Water Control Center. Part of Hydrology Section in Geotechnical, Hydraulics and Hydrologic Engineering Branch. Responsible for matters involving reservoir regulation.

(5) Geotechnical Design Section. A section in Geotechnical, Hydraulics and Hydrologic Engineering Branch. Responsible for matters involving the structural integrity of the dam.

(6) Design Branch. Responsible for matters involving the structural integrity of the outlet structures.

(7) Project Management Branch. Responsible for management support.

(8) Planning Division. Responsible for management support, and matters involving environmental analysis and cultural resources.

A-3. Responsibility For Conduct

a. Park Manager

(1) Carrying out routine surveillance (paragraph A-4a).

(2) Carrying out non-routine observations and measurements as directed by the District (paragraph A-4b).

(3) Advising District of potentially hazardous situations (paragraph A-4c). (See Table A-1).

(4) Maintaining proper records of communications (paragraph A-5).

(5) Acting independently, when required by disruption

of communications or the urgency of the circumstances, to declare a Pre-Emergency or Emergency condition (paragraph A-8) and to activate the Notification Subplan and/or Emergency Operations and Repair Subplan as appropriate. (See Table A-1).

b. Western Flood Control Office

(1) Provide direction and supervision to the Park Manager in coordination with the District Office.

(2) Providing assistance to District as requested.

(3) Assuming responsibilities of District in event of disruption of communications between the project area and the District Office.

c. District

(1) Carrying out routine monitoring of conditions potentially affecting regulation of Lac qui Parle Dam (paragraph A-6a) and alerting the Park Manager of situations requiring increased readiness and/or 24-hour supervision.

(2) Providing guidance to the park manager on all potentially hazardous situations which arise and directing any non-routine observations and measurements needed to assist in identification, confirmation or analysis of existing or impending threats to safe operation of the dam (paragraph A-6b).

(3) Providing personnel for on-site evaluation of potentially hazardous conditions relating to geology, soils and other aspects requiring expert analysis.

(4) Declaring the existence of Pre-Emergency and Emergency conditions and directing activation of the Notification Subplan and/or Emergency Operations and Repair Subplan. (See Appendices B & C).

(5) Maintenance of the subplan (paragraph A-9).

A-4. Observations, Tests and Reports by Park Manager

a. Routine Observations and Tests

(1) Monday thru Friday (0800 - 1630).

(a) Local precipitation at Maintenance Building.

(b) Pool and tailwater elevations at Lac qui Parle Dam, Marsh Lake Dam, Chippewa River Diversion Dam and Watson Sag Channel.

(c) Gate setting, Chippewa Diversion Dam and Lac qui Parle Dam.

(2) Monday, Wednesday, Friday (0800 - 1630) at Lac qui Parle Dam.

(a) Visual inspection for excess seepage of downstream face of embankment, weir, discharge pipes into outlet works, abutment areas, and valley floor immediately downstream of dam.

(b) Visual inspection for slope failure of both faces of all embankments which are in contact with standing water.

(3) Monday, Wednesday, Friday (0800 - 1630) at Marsh Lake Dam.

(a) Visual inspection for excess seepage of downstream face of embankment, weir, discharge pipes into outlet works, abutment areas, and valley floor immediately downstream of dam.

(b) Visual inspection for slope failure of both faces of all embankments which are in contact with standing water.

(4) Weekly

(a) Watson Sag Channel.

(1) Visual inspection for excess seepage of downstream face of embankment, weir, discharge pipes into outlet works, abutment areas, and valley floor immediately downstream of dam.

(2) Visual inspection for slope failure of both faces of all embankments which are in contact with standing water.

(b) Chippewa River Diversion Dam.

(1) Visual inspection for excess seepage of downstream face of embankment, weir, discharge pipes into outlet works, abutment areas, and valley floor immediately downstream of dam.

(2) Visual inspection for slope failure of both faces of all embankments which are in contact with standing water.

(c) Snow cover, water content (seasonal) at maintenance building.

(d) Test radio, and other communications equipment.

(e) Read lake gages throuout the region.

b. Non-Routine Observations and Tests

(1) Perform snow surveys as requested (seasonal).

(2) Perform comprehensive examination of seepage (amount, rate of change of flow, and presence of fines) whenever potential problems are observed.

(3) Monitor precipitation gages as directed by the District Office when significant rain is occurring.

(4) Examine all areas of embankment hourly if evidence of significant slope failure is found (to be continued until directed by District to cease).

(5) Perform other observations and tests as directed by the District Office.

c. Reports

(1) To the Chief, Water Control Center (see Table A-1).

(a) Reports precipitation of 1.5 inches or more in 24-hours or less in the vicinity of the dam.

(b) Pool elevation above normal seasonal.

(c) Reported severe ice conditions or temporary constrictions downstream of dam.

(d) Any conditions likely to require a change in gate operations or mode of regulation.

(2) To the Chief, Foundation and Materials Section (see Table A-1).

(a) Any conditions indicating distress of an embankment.

(b) Indications of unusual seepage.

A-5. Records

The Park Manager will keep a log of all telephone, radio or other communications received from or sent to the District Office. This log should be a bound ledger or notebook used only as an official diary. Each communication will be described including:

a. Date

b. Time

c. Person called or calling

d. Information transmitted/instructions received

e. Action requested by the District

f. Action taken in response to request

g. Result of action

h. Remarks

i. Name of operator issuing information/orders

j. Initials of person receiving communications

A-6. Observations, Tests and Alerts by District Office

a. Daily Routine Observations and Tests

(1) Check weather forecasts for areas affecting runoff.

(2) Check concurrence of pool level readings from staff gage and recording gage.

(3) Record, review and analyze piezometer and weir reading data and check with Geotechnical Design Section.

b. Non-Routine Observations and Tests

Specify additional observations and tests by the Park Manager and make additional observations and tests as necessary to:

(1) Assure proper functioning of all instrumentation.

(2) Assist in identification, confirmation or analysis of existing or impending threats to safe operation of the dam.

c. Alerts

Provide alerts to Park Manager and appropriate District Office personnel when:

(1) Weather, ice or other conditions require heightened readiness, increased surveillance or the possible need for activation of the Emergency Operating Center. (See Appendix C).

(2) Consideration is being given to declaration of a Pre-Emergency or Emergency Condition.

A-7. Communications

a. Normal

Communications between the District and Park Manager will normally be by radio. Radios at the Electronic Service Center and District's Emergency Operating Center will be manned on a 24-hour basis during all flood emergencies and whenever a Pre-Emergency or Emergency condition is in effect. Radio frequencies and call letters for pertinent parties are listed in Table A-1. (See Annex C to ER 500-1-1).

b. Back-Up

The telephone communications network between the District Office and the Western Flood Control Project Office will be used to back-up radio communications. Office and home phone numbers of key District Office and Western Flood Control Project Office personnel are listed in Table A-1.

c. Emergency

During a situation when both radio and telephone communications between the District Office and the Lac qui Parle

project office are lost, others equipped with radio or telephone facilities will be called on for assistance. Those to whom application for assistance may be made are listed in Table A-1 along with information for telephone and radio contacts.

A-8. Declaration of Pre-Emergency and Emergency Conditions

a. Responsibility

The District Office is responsible for the declaration of "Pre-Emergency" or "Emergency" conditions in all but extreme cases where the loss of communications or the speed of onset of a situation prevents the Park Manager from conferring with the District Office.

Pre-Emergency and Emergency declarations will be made by the Commander/District Engineer. The Chief of Engineering Division, members of Geotechnical, Hydraulics and Hydrology Branch, Design Branch, Project Operations Branch and the Emergency Operation Center will provide recommendations for the decision making process.

b. Conditions Warranting Declaration

Not every situation requiring declaration of a Pre-Emergency or an Emergency condition can be specified. Initiative must be exercised by all involved personnel and each situation judged individually on the basis of all relevant factors.

(1) Pre-Emergency

Examples of circumstances warranting declaration of a Pre-Emergency condition include:

(a) Spring runoff is always handled as a pre-emergency condition. During the remainder of the year, a discharge of 1,500 cfs, or more shall be the warranting factor.

(b) Malfunction of the flood control gate system during flood operations which impedes release of water and creates potential for spillway flow.

(c) Minor seepage problems including: unexplained increases or decreases in amount, cloudy appearance of seepage or presence of fines, development of new seepage areas as indicated by soft boggy areas or new or lush vegetation, and substantial unexplained fluctuation in piezometer readings.

(d) Minor slope failures including: tension cracks at crest or in slopes of embankment, small bulges in slopes or in foundation near toe of slope, small depressions or sags in crest or slopes, changes in horizontal crest alignment, and gullies forming in or near embankment or junction of the embankment and abutments.

(e) Threats of sabotage or occurrence of sabotage of non-critical project features.

(2) Emergency

Examples of conditions warranting declaration of an Emergency condition include:

(a) Lac qui Parle Lake is over elevation 939.0, inflow is increasing and Montevideo, MN is near flood stage.

(b) Major seepage problems including: large increases in piezometer readings, movement of large amounts of material in existing or new seeps, pipes in embankment or foundation materials, seepage at higher elevations on downstream face of dam or in abutment areas, and substantial increases in normal seepage amounts (especially when associated with movement of material from embankment of foundation).

(c) Major slope failures including: appreciable depressions or sloughs in the crest or slopes of the dam or bulges in the slopes or foundation, large gullies developing and continuing to erode in the embankment or at the junction of the embankment and abutments, displacement of structures or instrumentation on the dam and continuing expansion of tension cracks after their appearance on the dam crest or slope.

(d) Threats of sabotage or occurrence of sabotage to critical project features.

c. Action Upon Declaration

(1) Park Manager

(a) Attend telephones as directed by the District office. Cancel normal work schedule and provide for 24 hour duty as needed.

(b) Activate appropriate portions of Notification Subplan and Emergency Operations and Repair Subplan. (See Appendices B & C).

(c) Maintain monitoring/surveillance of situation responsible for declaration.

(d) Perform non-routine observations and tasks as directed by the District Office.

(e) Test radio communication.

(f) Request assistance needed from the District Office to perform (a) through (e) above.

(2) Western Flood Control Project Office

(a) Place all personnel on standby for emergency duty if directed by District office.

(b) Test radio communications.

(3) District Office

(a) Activate Emergency Operation Center.

(b) Attend telephones on 24 hour basis.

(c) Test radio communications.

(d) Place key staff on standby for emergency duty. (See Table A-1).

(e) Provide detailed instructions to the Park Manager for directing specific non-routine observations and tests.

(f) Dispatch personnel to dam site as required to provide expert evaluation of situation and to assist Park Manager as needed.

(g) Activate appropriate portions of Notifications and Subplan and Emergency Operations and Repair Subplan. (See Appendices B & C).

A-9. Subplan Maintenance

a. Updating

This subplan shall be updated as needed by the Dam Safety Officer, including:

(1) Annually.

(2) Whenever needed by modifications in instrumentation at or affecting the project, dam operating procedures, overall District emergency procedures, and/or changes of personnel.

b. Testing

The Chief, Project Operations Branch shall annually direct a thorough inspection of all mechanical, electrical and other equipment pertinent to conduct of this subplan. The inspection shall include all tests, servicing and calibration necessary to ensure proper functioning.

c. Familiarization

The Dam Safety Officer shall ensure all pertinent Corps personnel are aware of and familiar with this subplan including:

(1) Circulation of each updated version for review and signature by pertinent District staff, Western Flood Control Project Office and the Lac qui Parle Project Office.

(2) Annual review session with staff of the Water Control Center and Park Managers.

(3) Briefing, within two weeks of assuming duties, of all new Water Control Center staff.

(4) Briefing, before assumption of duties, of any new Park Manager.

TABLE A-1
Information on Key Contacts

| PARTY | TELEPHONE NUMBER OFFICE | TELEPHONE NUMBER RESIDENCE | RADIO FREQUENCY | RADIO CALL LETTERS |
|---|---|---|---|---|
| DISTRICT PERSONNEL | | | | |
| Resource Manager | | | | |
| Curt Hanson | (612)269-6303 | (612)654-3145 | SSB | WUD630 |
| Western Flood Control Project Office | | | | |
| Tim Bertschi | (701)232-1894 | (701)232-5967 | SSB | WUD642 |
| St. Paul District Office | | | | |
| Emergency Operations Center<br>Twenty-four (24) hour telephone service. Must be kept informed of all pre-emergency or emergency situations. Also contact for matters involving national security, disasters, mobilization or NWS flood forecasts. Center will contact Dam Safety Officer, the Commander/District Engineer and NCD. | | | | |
| District Emergency Operations Center | (612)220-0208 | | Contact Hastings | |
| David Christenson, Chief, Emergency Management | (612)220-0204 | (612)690-5749 | Electronic Service | |
| Natural Disaster Planner | (612)220-0204 | | Center at (612)437-2210 (call letters - WUD6) | |
| Project Operations Branch<br>Responsible for identifying a person-in-charge of the pre-emergency or emergency situation. Must be kept informed of all pre-emergency or emergency situations. Also contact for matters involving normal dam operations, and/or matters not covered by other District elements. Project Operations Branch will contact Dam Safety Officer for engineering and technical assistance and keep him informed of situation. | | | SSB(Primary - 5400Khz)<br>1st Alternate- 6060Khz<br>2nd Alternate- 2604Khz<br>3rd Alternate- 2350Khz<br>(Emergency- 5015Khz LSB) | |
| Dennis Erickson, Chief, Natural Resource Management Section | (612)220-0325 | (612)452-6850 | | |
| Thomas Oksness, Chief, Lock and Dam Section | (612)220-0322 | (612)439-0272 | | |
| Dennis Cin, Chief, Project Operations Branch | (612)220-0320 | (612)455-6786 | | |

TABLE A-1 (Continued)
Information on Key Contacts

| PARTY | TELEPHONE NUMBER OFFICE | TELEPHONE NUMBER RESIDENCE | RADIO FREQUENCY | RADIO CALL LETTERS |
|---|---|---|---|---|
| Dam Safety Officer<br>To be informed of all pre-emergency or emergency situations. Responsible for identifying and/or the providing necessary engineering or technical support required to resolve the pre-emergency or emergency situation. | | | | |
| Robert Post, Chief, Engineering Division | (612)220-0303 | (612)437-1316 | | |
| Water Control Center (3)<br>For matters involving reservoir regulation. | | | | |
| Edward Eaton, Water Control Center (1) | (612)220-0617 | (612)731-9426 | | WUD 613 |
| Bonnie Montgomery, Water Control Center (1) | (612)220-0618 | (612)450-0909 | | WUD 613 |
| Gordon Heitzman, Water Control Center (1) | (612)220-0620 | (612)429-9500 | | |
| Kelsey Willis, Water Control Center (1) | (612)220-0619 | (612)566-5022 | | WUD 613 |
| Helmer Johnson, Chief, Geotechnical, Hydraulics & Hydrology Branch (1) | (612)220-0602 | (612)633-7791 | | |
| Geotechnical Design Section (3)<br>For matters involving the structural integrity of the dam. | | | | |
| W. Grant Westall,Geotechnical Design Section | (612)220-0644 | (612)455-7632 | | |
| Helmer Johnson, Chief, Geotechnical Hydraulics & Hydrology Branch | (612)220-0602 | (612)633-7791 | | |

TABLE A-1 (Continued)
Information on Key Contacts

| PARTY | TELEPHONE NUMBER OFFICE | TELEPHONE NUMBER RESIDENCE | RADIO FREQUENCY | RADIO CALL LE |
|---|---|---|---|---|
| Design Branch (3) | | | | |
| For matters involving the structural integrity of the outlet structures. | | | | |
| Greg Frankosky, Chief, Structural Engr. Section (1) | (612)220-0582 | (612)432-1606 | | |
| Charles Spitzak, Chief, General Engr. Section (1) | (612)220-0512 | (612)645-7301 | | |
| Robert Fletcher, Chief, Design Branch (1) | (612)220-0510 | (612)484-4998 | | |
| Others (3) | | | | |
| If none of the above can be reached. | | | | |
| Dale Mazar, Chief, Project Management Br. (2) | (612)220-0444 | (612)631-1940 | | |
| Wayne Knott, Chief, Environmental Resources Br. (2) | (612)220-0400 | (612)739-2724 | | |
| Louis Kowalski, Chief Planning Division (2) | (612)220-0307 | (612)457-6453 | | |
| LTC. David Nelson, Deputy Commander (2) | (612)220-0301 | (715)247-5661 | | |
| COL. Roger L. Baldwin, District Commander (2) | (612)220-0300 | (612)894-6410 | | |
| External | | | | |
| State of Minnesota Statewide Emergency Number | 1-800-422-0798 | | | |
| Metro Area | (612)649-5451 | | | |
| Backup Only | (612)296-2100 | | | |
| 4 State Patrol | (612)482-4901 | | | |
| County or Local | | | | |
| Lac qui Parle Civil | | | | |
| Defense Director | (612)598-3720 | (612)598-7751 | | |
| Tri-County | | | | |
| Defense Director | (612)269-8583 | (612)269-9102 | | |

1. Call personnel in order listed until contact is made.
2 To be called in the order listed.
3 To be contacted if no contact can be made with other elements.
4. Potential Sources of Assistance in Communication

# EMERGENCY OPERATIONS AND REPAIR SUBPLAN

## APPENDIX B

to

## EMERGENCY PLAN

for

## LAC QUI PARLE FLOOD CONTROL PROJECT

OCTOBER 1988

TABLE OF CONTENTS

LIST OF TABLES

## LIST OF PLATES

EMERGENCY OPERATIONS AND REPAIR SUBPLAN
LAC QUI PARLE FLOOD CONTROL PROJECT

B-1. Introduction

Conditions affecting operation of Lac qui Parle flood control project could result in a hazard to life and/or property due to high reservoir levels or sudden release of large volumes of water. Prompt conduct of emergency operations and repairs is essential for minimizing hazards to life and property.

a. Purpose

This subplan implements a portion of the Corps program to prepare emergency plans for all Corps dams. It establishes procedures for emergency operations and repairs to deal with impending and existing emergencies affecting the operation and safety of Lac qui Parle flood control project.

b. Scope

This subplan describes emergency operations and repairs to be implemented upon declaration of a Pre-Emergency or Emergency condition. Operations and repairs are described for cases of:

(1) Excess seepage and/or malfunctioning of the dam's internal drainage system.

(2) Wave erosion and/or erosion of downstream face of embankment.

(3) High reservoir level.

(4) Slope failure.

(5) Threatened sabotage.

(6) Sabotage.

c. Applicability

This subplan is applicable to all Corps elements and field offices concerned with operation of Lac qui Parle flood control project.

B-2. Definitions

a. Pre-Emergency

A "Pre-Emergency" condition is one in which some impending or existing threat to the safe operation of the dam or reservoir is identified but no significant hazard to life or property is expected to occur.

b. Emergency

An "Emergency" condition is one in which the occurrence of a significant hazard to life and/or property is possible or certain to occur. Conditions justifying declaration of an Emergency condition may be imminent or longer term.

c. Park Manager

The term "Park Manager" means the dam tender or the individual in charge at the Lac qui Parle project site.

d. Western Project Office

The term "Western Project Office" means the person in charge of the Project Office.

e. District

The term "District" means one of the following elements depending upon which is appropriate for the situation at hand.

(1) Dam Safety Officer. The Dam Safety Officer must be kept informed of all pre-emergency or emergency situations. Responsible for identifying and/or providing the necessary engineering or technical support required for the pre-emergency or emergency situation. Also responsible for keeping the Dam Safety Committee, and the NCD Dam Safety Officer informed of the pre-emergency or emergency situation.

(2) Project Operations Branch. Responsible for identifying a person- in-charge of the pre-emergency or emergency situation. Responsible for keeping the Dam Safety Officer informed of the pre-emergency or emergency situation. Also responsible for matters involving normal dam operations, and/or other matters not covered by the other District elements.

(3) EmergencyOperationsCenter. Provides a 24-hour telephone contact with District Office. Responsible for keepin Dam Safety Officer, the Commander/District Engineer, and NCD i

contact with the operations and personnel. Also responsible for matters involving national security, disasters, and mobilization.

(4) Water Control Center. Part of Hydrology Section in Geotechnical, Hydraulics and Hydrologic Engineering Branch. Responsible for matters involving reservoir regulation.

(5) Geotechnical Design Section. A section in Geotechnical, Hydraulics and Hydrologic Engineering Branch. Responsible for matters involving the structural integrity of the dam.

(6) Design Branch. Responsible for matters involving the structural integrity of the outlet structures.

(7) Project Management Branch. Responsible for management support.

(8) Planning Division. Responsible for management support, and matters involving environmental analysis and cultural resources.

B-3. Basis of Activation

This subplan is to be activated immediately upon declaration of a Pre-Emergency or Emergency Condition.

B-4. Responsibilities

a. Park Manager

(1) Provide information to District on existing severity and rate of change of problem.

(2) Request needed assistance from the District includir

(a) Personnel, including expert supervision.

(b) Equipment.

(c) Materials.

(3) Carry out operations and repairs as directed by District.

(4) Act independently to implement emergency operations and repairs in the event communications with the District are disrupted or immediate action is required including:

(a) Deciding the urgency of correction.

(b) Carrying out appropriate portions of the emergency operations and repairs.

(c) Obtaining needed personnel, equipment and materials (see paragraph B-12).

b. Western Flood Control Office

(1) Provide direction and supervision to the Park Manager in coordination with the District Office.

(2) Providing assistance to District as requested.

(3) Assuming responsibilities of District in event of disruption of communications between the project area and the District Office.

c. District

(1) Assess problem and park manager's request for assistance with respect to:

(a) Urgency for correction.

(b) Type of corrective actions required.

(c) Personnel required for corrective actions including requirements for expert advice and/or on-site supervision.

(d) Equipment and materials required for corrective actions.

(2) Provide direction to the park manager on emergency operations and repairs to be carried out.

(3) Dispatch needed personnel, equipment and materials to the project from the District (see paragraph B-12).

(4) Arrange for needed personnel, equipment and materials from sources other than District.

## B-5. Emergency Operations and Repairs - Excess Seepage and/or Malfunctions of the Dam's Internal Drainage System

### a. Potential Problems

Abnormal seepage may occur as rapid and/or significant increases in the amount of flow through the sand collection blanket or the seepage drains emptying into the outlet works; boils in the embankment or foundation; and creation of new seep areas on the downstream face of the embankment, foundation, abutments or areas immediately downstream of the embankment. Seepage high on the face of the embankment, large amounts of seepage, and seepage carrying fines are especially serious. Boils and seep areas may also be caused by a malfunction of the dam's internal drainage system. Excess seepage problems are most likely to occur when the reservoir water level is at higher than normal elevation.

### b. Corrective Action

Individual boils or small areas of seepage can be controlled on a temporary basis by ringing them with sand bags or other materials. Longer-term control and control of large areas of seepage can be effected by covering the area with a 3 to 5 feet deep granular material graded from coarse sands at the bottom to coarse gravels at the top. Lowering of the reservoir pool level reduces pressure on seepage areas and aids in control.

#### (1) Solutions to Combat Sand Boils.

A sand boil may gradually undermine a dam and result in a failure by causing settlement and sloughing of the dam. As long as the flow is steady and not increasing, and no material is being carried, the danger is relatively small. In times of forecasted high water all locations of prior boils and any newly developed boils should be watched closely, especially those within 100 feet of the toe of the embankment. All boils should be conspicuously marked with flagging so that patrols can locate them without difficulty and observe changes in their conditions. A sand boil which discharges clear water in a steady flow is usually not dangerous to the safety of the dam. The only action necessary in this case is to drain the excess water off to prevent it from standing near the dam. However, if the flow of water increases and the sand boil begins to-

discharge material, corrective action should be undertaken immediately.

A common method of handling sand boils involves walling up a water tight sack ring aroung the boil until the water in the ring has attained sufficient head to counteract the head causing the boil. This is shown graphically on Plate B-1. Ringing boils with steel piling is shown on Plate B-2. It is not necessary or desirable to check the flow of water completely, as this may cause other boils to break out in the vicinity. It is necessary, however, to reduce the velocity of flow, and to stabilize the movement of sand, silt and other materials thorugh which the water stream passes. (A boil at the toe of the embankment is not necessarily more dangerous than one at a considerable distance landward from the toe.

(2) Solutions to Combat Seepage

Remedial measures to combat excessive embankment seepage may be performed on either the upstream or downstream slopes.

(a) Downstream remedial work should allow the seepage water to flow as freely as possible while reventing migration or loss of existing soil materials from the embankment or foundation. If seepage causes sloughing of the landward slope, it should be flatened to a 1V or 5H slope or flatter. Since seepage on a slope indicates effective pervious embankment behavior or worse, material for flattening must be more pervious than the embankment material.

(b) The upstream treatment, when the seepage is heavy or the embankment shows signs of sloughing, would consist of blanketing or sandbagging the area under the pool with additional earthen or other materials. This would minimize the entry of water into the foundation and/or the embankment.

(c) When water does seep through a foundation or embankment, material maybe carried along with it, causing sink holes to appear in the

embankment. These holes should be filled with sandbags or earthen material as soon as possible.

c. Resources Required

(1) Resources Required for Combatting Seepage (Placing Granular Blanket).

(a) Materials

The characteristic of sand and gravel mixtures to allow the passage of water while at the same time preventing the passage of soil grains is extensively used in the design of water retaining structures. The properties of resistance to displacement by flowing water, resistance to wear from vehicular traffic, and the maintenance of strength and limited volume change over a large range of water contents make sand and gravel useful in providing surface protection to dams and canal banks. The wide range in gradation possible in sand and gravel mixtures, together with the wide range in structural materials to be protected, results in a wide range of acceptability for the materials used for sand and gravel or crushed rock blankets. The engineering properties and uses for various soil types are listed on Plates B-8 and B-9.

Natural sand and gravel deposits normally contain excessive amounts of sand. However, if these materials are clean (contain less than 5 percent fines), almost any sand and gravel mixture can be used for downstream drainage blankets for earth dams by thickening the pervious blanket sufficiently so that seepage through the embankment and foundation can be carried within the blanket section. For some cases involving seepage through the foundation, it can be shown that the blankets effective weight must be equivalent to or greater than the total head in order to prevent rupturing boils or piping. Sometimes only 50 to 75 percent of the total head is required for effective weight of the blanket.

For the pervious blankets between riprap and rolled earthfill, the requirements for the sand and gravel material become less critical as the thickness of the riprap layer increases. Generally, material from a natural deposit can be utilized if at least 50 percent of the material is in the gravel size range when riprap blankets of 3-foot normal thickness are specified. In those ranges of reservoir operation where anticipated wave action is comparatively rare, some relaxation of material requirements is also possible.

(b) Equipment

Placement of granular blankets requires equipment including:

(i) Dump trucks for transportation of materials to point of placement. The number of trucks required depends on the haul time and desired time of completion.

(ii) Tractors with blade for grading. One tractor is usually sufficient for areas up to about 500 square feet per hour.

(iii) Shovels and rakes for hand placement of materials.

(c) Personnel

In addition to drivers for trucks and other mechanized equipment, labor is required for various other tasks. The number of personnel required for this purpose depends on the size of area being treated and desired speed of completion. Labor requirements for various tasks can be approximated from Tables B-1, B-2, and B-3.

(2) Resources Required For Ringing Boils

(a) Materials

Materials required for ringing boils include:

(i) Sandbags.

(ii) Sand.

(b) Equipment

Shovels are the only equipment required for ringing small boils. For larger areas of seepage, consideration should be given to use of a granular blanket. In the event larger areas must be treated by sandbagging, consideration should be given to use of transit concrete trucks, front end loaders or other mechanized equipment to fill and move bags. Typical sections for ringing boils are shown on Plates B-1 and B-2.

(c) Personnel

Curves to estimate the time (in hours) needed to place sandbags to construct various sizes of sandbag rings under various conditions are shown on Plate B-3.

(3) Lowering of Reservoir Pool Level

(See Reservoir Regulation Manual, Reference 10).

d. Technical Directions

(1) Placing Granular Blanket

A requirement of all blankets is careful placement. Requirements may vary widely according to the type and location of the blanket placement, but in every case uniformity and thickness are very important. (For additional information see Earth Manual, Reference 26).

(2) Ringing Boils

(a) Multiple nearby boils or soft areas in vicinity of boil should be included within sandbag ring.

(b) Build ring only high enough to slow water flow to point that no fines are carried. However, do not completely shut off the flow of seepage.

(c) Base of sandbag ring should be at least one and a half times the contemplated height. Typical sections for ringing boils are shown in Plages B-1 and B-2.

(3) Sandbags

Procedures for filling, handling, and placing sandbags are presented in Section B-6 of this report.

B-6. Emergency Operations and Repairs-WaveDamage and/or Erosion of the Downstream Face of Embankment.

a. Potential Problems.

Wave damage may occur during a period of high winds out of the North and Northwest at the Marsh Lake and Lac qui Parle dam sites and out of the North at the Chippewa River Diversion Dam. Damage may include displacement of riprap and/or erosion of the underlying materials causing collapse of the riprap. Wave damage is particularly serious during abnormally high reservoir pool levels when damaging erosion can cause a sudden collapse of the crest with subsequent overtopping of the embankment.

Description. Wave wash is the erosion of the upstream slope of the dam by wave action. This action may be caused by storms, shore winds and may be particularly dangerous on open reaches where the slope is not protected by riprap or timber and brush screens. Sand slopes and unsodded slopes are much more susceptible to wave wash than well sodded slopes. Wave action may seriously damage a dam, particularly if the water surface is near the dam crown, if the reservoir pool is constant for a relatively long period of time, or if a slope is newly constructed or of sandy soil. Although the necessity for wave action protection cannot always be foreseen, the probable spots where wave wash might occur as known from past observations, will give a good idea of where material and supplies should be concentrated. Upon discovery of a damaged wave wash section or the beginning of wave wash damage, action should be taken to prevent further damage.

b. Corrective Action.

The type of corrective action which is appropriate depends on the severity of damage, rate of progression of damage, and urgency of action. Temporary protection above and within 10-

12 feet of the waterline can be provided quickly by use of plywood or canvas or polyethylene sheets or by filling eroded areas with sandbags. Placement of polyethylene sheets is illustrated in Plate B-4. Protection further below the water level can be provided by dumping riprap in the affected area. A strip of cotton or burlap bag over the affected area weighted down by sandbags is very effective in combating erosion. Sack revetment and construction of sandbag barriers are illustrated in Plates B-5 and B-6, respectively. In cases of severe erosion, lowering of the reservoir pool level can shift wave forces to a lower elevation. Repairs normally require reconstruction of the eroded slope and replacement of both bedding materials and riprap. Lowering of the pool level is usually required prior to making permanent repairs.

c. Resources Required.

(1) Temporary protection with plywood

(a) Materials

(i) One-half inch exterior plywood.

(ii) Concrete blocks or sandbags for use as weights.

(iii) Stakes (2" x 4" x 3'-0").

(iv) 12 gauge galvanized tie wire.

(v) Tie cord

(b) Equipment

(i) Sledge hammers

(ii) Wire cutters

(iii) Pike poles

(iv) Shovels

(v) Drill, 1/4"

(c) Personnel

The number of personnel required to put various areas of protection in place using plywood can be approximated from Plate B-7.

(2) Temporary Protection with Canvas

(a) Materials

(i) Wavewash canvas, 7' wide

(ii) Stakes (2" x 4" x 3'-0")

(iii) One and one-half inch pipe for bottom stiffener (20' lengths).

(iv) Concrete blocks or sandbags for use as weights.

(v) 12 gauge galvanized tie wire

(b) Equipment

(i) Sledge hammers

(ii) Wire cutters

(iii) Pike poles

(iv) Shovels

(c) Personnel

The number of personnel required to put various areas of temporary wave protection in place using canvas can be approximated by making assumptions using plate B-7.

(3) Temporary Protection with Sandbags

(a) Materials

(i) Sand

(ii) Sandbags

(b) Equipment

(i) Sack racks and stabilizing pins

(ii) Shovels

(iii) Cement transit trucks

(iv) Other trucks

(v) Wheel barrows

(c) Personnel

The number of personnel required to fill and place sandbags can be approximated by assuming that under average conditions with a crew of 2 to 10 men and 1 crew leader it would take four hours to place one cubic yard by hand at the place of filling. Also, see Table B-3 and Plate B-3.

d. Technical Directions.

The construction of emergency protection projects is dependent on local working conditions, resources available, and the methods employed. The most efficient system of either mechanical or manual means of construction should be selected to meet the criteria of the emergency.

(1) Manual Labor

Manual labor can be a very effective way of accomplishing the necessary emergency tasks. Availability of a large work force or conditions that restrict the use of vehicles and/or mechanical devices, are examples of situations that lend themselves to the use of manual labor. The availability, need and use of manual labor should be given careful consideration ahead of time. Resources should be identified so that they can be quickly mobilized for an emergency.

(a) Sacking Operation

Sacks filled with earth material are suitable for almost every phase of emergency high water protection work. In many situations sacks provide the most practical and effective emergency deterrent. However, the labor force required (See Plate B-3), duration of placement and cost, including purchase, filling, handling and removal should be considered, with discretion exercised so that the application of sacks is advantageous when compared to other methods.

(i) Filling Sacks

(aa) For seepage sandboil control, a completely filled sack is

detrimental. Instead a half filled sack should be used.

(bb) For wave erosion protection the sacks should be well filled and the material shaken down into the sack, but not tamped. A well filled sack will measure approximately 12" x 24" x 8" and will contain 1 1/3 cubic feet of material, weighing about 130 pounds. Sacks for wave erosion protection should be sewn shut at the top.

(cc) The top of each sack can be loose, tied or sewn depending on the proposed use. If large curved steel needles are not readily available for sewing the sacks, suitable needles can be made out of almost any kind of wood. The wooden needle should be about 7 inches long, whittled down to a diameter which will permit passage through the sack material - about 1/4 inch to 5/8 inch - with a large eye cut in one end and a point on the other. Any heavy twine is suitable for sewing the sacks.

(dd) When it is necessary to fill a large number of sacks in a short period of time, a sack rack should be used. One type of sack rack can be made by driving three stakes in the ground with their tops above the ground to the approximate height of the sack.

(ii) Transporting Sacks

Sacked material may be transported around the site in wheelbarrows, in handbarrows, or on people's shoulders.

(aa) Wheelbarrows are preferable as two filled sacks constitute a load for

one wheelbarrow which can be handled by one person if smooth-run planks and a suitable grade are provided.

(bb) When necessary, filled sacks are transported on a person's shoulder, one sack per person.

(cc) Handbarrows, carried by two people, can be used to transport two sack loads over longer distances. A handbarrow may be made of two hand bars and two sacks. The hand bars are two poles about 5 feet long, from 1 1/2" to 2" in diameter. Any local wood that has sufficient strength is suitable. The hand- barrow is assembled by slipping the hand bars through the bottom corners of an empty sack, taking care not to slit the openings in the sack larger than necessary. The second sack is slipped on in a similar manner, but in the reverse direction so that one sack is telescoped into the other. The sacks should be securely fastened to the hand bars by small nails.

(dd) Under certain situations, consideration should be given to filling sacks off site and transporting them to the problem area by truck or perhaps on pads flown to the spot by cargo type helicopters. In instances where vehicles must be sent over roads that are impassable due to mud or sand, their safe passage may be provided by the use of a plank road. When travel or other satisfactory means of communication cannot be maintained, telephone communication should be provided along dangerous stretches of the dam.

(2) Mechanical Methods

If an emergency project is large and/or must be completed quickly, consideration should be given to the use of mechanical methods. They offer a versatile and effective way to construct emergency works in situations that require the rapid deployment of equipment and labor force, in order to meet the urgent time requirements that emergencies demand.

(a) Mechanical Methods for Sacking

Sacking operations can be accelerated with the use of mechanical equipment. A small trenching machine can dig material and discharge it to the side. Another scheme would be to use a small dragline and combination hopper-belt conveyor so that sacks could be filled directly on trucks with a minimum of laborers required.

(b) Mechanical Tools to Speed Up Production

If conditions warrant, electric saws, air hammers, etc., could be used to speed up the mass production of such articles as cribs, board sections of movable wavewash protection and other earth retaining structures.

(c) Use and planning of Mechanical Methods

The use of mechanical equipment calls for innovative and immediate decisions to insure that the required emergency protective works are constructed as quickly as possible.

Repair procedures and where to obtain heavy equipment, tools, materials and other resources, should be given serious thought and action during nonflood seasons so that they can be carried out in the most efficient manner possible.

B-7. Emergency Operations and Repairs - Abutment, Foundation, o Embankment Failure

During periods of above normal pool, the abutments, foundation, and embankment should undergo close inspection Also, after periods of high pool a close inspection should b made to assess significant changes in these features Notification of any potential pre-emergency conditions o emergency conditions should be immediately made following th guidance in Appendix C.

B-8. Emergency Operations and Repairs - High Reservoir Level

a. Potential Problems

High reservoir levels cause large hydrostatic forces o the dam, reduce freeboard available to contain wave action an reduce the capability of the dam to impound major inflows withou overtopping or uncontrolled spillway flow. High reservoir level contribute to excess seepage, piping, wave erosion and othe safety problems. High water levels can also result in propert damage and creation of safety problems around the periphery o the lake.

b. Corrective Action

The only corrective action for high water levels is increasing releases. (See Reservoir Regulations Manual Reference 10).

B-9. Emergency Operations and Repairs - Slope Failure

a. Potential Problems.

Slope failure may occur as the mass movement of a portio of the embankment. Such failures weaken the dam, and if locate sufficiently high on the embankment may cause a breach, or lea to collapse of the dam crest. Slope failures of any significiar magnitude are serious and require immediate corrective actior and notification of proper personnel according to Appendix C.

b. Corrective Action.

(1) Lowering of the upstream pool should be done i the event of any slope failure that is sufficiently serious to threaten the safety of t dam or dike areas. (See Reservoir Regulatio Manual, Reference 10).

(2) Immediate treatment of slope failures consists o filling slide areas with rip rap, sand bags or granular blanket. The preferred method depends o materials and labor available and the urgency o action. When the urgency of the situation permits, filling of slide areas will be carrie out under supervision of District staff an constitute rebuilding of the affected portion o the embankment. Immediate treatment in urgent situations will consist of filling slide areas with sand bags, rip rap or other available materials. The methods used would be the same a those discussed in Section B-5 and B-6.

B-10. Emergency Operations and Repairs - Threatened Sabotage

a. Potential Problems.

Threats of sabotage are most likely to be received fro individuals or groups with little intention of carrying throug with action. However, all such threats are to be take seriously. Threats considered most pro- bable to occur are thos related to disruption of communications, blocking access to th project, and interference with project operations. Threats coul also relate to damaging the embankment or other key projec features affecting safety.

b. Corrective Action.

(1) All threats concerning Lac qui Parle Dam and Reservoir will be reported immediately to the Federal Bureau of Investigation and to the District's Hydraulics and Hydrology Branch Others should be notified according to Appendix C

(2) Immediate assistance to secure and protect the dam, dikes and appurtenent facilities will be requested in the event a threatened action coul jeopardize the safety of project visitors and staff or downstream areas if carried out. Agencie from which law enforcement assistance can be obtained are listed in Table C-2.

(3) Every effort shall be made to operate Lac qu Parle Dam and Reservoir so as to avoid injury t all parties. However, the possible catastrophi consequences of dam failure require that action necessary to maintain the safety of the dam mus not be compromised by persons seeking to block access to the site, limit reservoir levels or

releases, or otherwise impede essential operations.

B-11. Emergency Operations and Repairs - Sabotage

a. Potential Problems.

Acts of sabotage may range from minor disruptions to quasi-military attacks by knowledgeable and well equipped professionals. The effects of sabotage fall into one of three categories: a) not affecting safety of the dam; b) posing a minor or future safety problem; or c) posing an immediate, serious safety problem.

b. Corrective Actions.

(1) All acts of sabotage will be reported immediately to the Federal Bureau of Investigation and to the District's Hydraulics and Hydrology Branch.

(2) Immediate remedial action shall be initiated in all cases of sabotage causing an imminent or future safety problem of a serious nature. As appropriate, remedial action shall include:

(a) Declaration of an emergency condition and activation of the Notification Subplan. (See Appendix C).

(b) Activation of the emergency drawdown (Reference 10).

(c) Initiation of emergency repairs according to the nature of damage.

B-12. Inventory of Resources

Resources available at the District level for carrying out emergency operations and repairs are listed in Table B-4. An inventory of available contractors and vendors at the Project Office level is shown on Table B-5.

TABLE B-1

EMERGENCY LABOR REQUIREMENTS - EARTH FILL STRUCTURES (1)

| | | MAN-DAYS PER UNIT | | |
|---|---|---|---|---|
| WORK ELEMENT DESCRIPTION | UNIT | ADVERSE CONDITION | AVERAGE CONDITION | FAVORABLE CONDITION |
| Excavate and Load | 1000 CY | 11.2 | 6.9 | 2.5 |
| Hauling | 1000 yard miles | 5.2 | 3.1 | 1.4 |
| Spreading and Compacting | 1000 CY | 18 | 9 | 4 |
| Erosion Control: riprap (12" thick) | 1000 CY | 22.5 | 15.0 | 7.5 |
| For Quick Estimates: earth fill structure, complete (2) | 1000 CY | 54 | 35 | 15 |

Typical crews: 1 crew leader, 3 to 5 men plus equipment for clearing and grubbing; 1 man with equipment removing top soil and clearing borrow pit; 1 crew and 2 to 5 men with equipment excavating and loading; 5 to 15 men with equipment hauling; 1 crew leader and 3 to 7 men spreading and compacting fill; 1 crew leader and 5 to 10 men installing erosion control plus equipment and men hauling materials.

(1) Reference- FM 5-35, Table 16-21.
(2) Includes all clearing, borrowing, hauling, compacting and erosion control.

TABLE B-2

EMERGENCY LABOR REQUIREMENTS - EROSION CONTROL (1)

| WORK ELEMENT DESCRIPTION | UNIT | MAN-DAYS PER UNIT ADVERSE CONDITION | AVERAGE CONDITION | FAVORABLE CONDITION |
|---|---|---|---|---|
| Machine Work: | | | | |
| Sloping shoulders, banks and ditches | 1000 SY | 4.0 | 2.6 | 1.3 |
| Hauling riprap or rubble | 1000 yard miles | 5.2 | 3.1 | 1.4 |
| Placing riprap or rubble (12" thick) | 1000 CY | 18 | 12 | 6 |
| Hand Work: | | | | |
| Sloping shoulders, banks and ditches | 1000 SY | 33 | 22 | 11 |
| Placing riprap or rubble | SY | 0.09 | 0.06 | 0.03 |
| For quick estimates: | | | | |
| Erosion control - riprap (12" thick) | 1000 SY | 22.5 | 15.0 | 7.5 |

Typical crew: Sloping shoulders, banks and ditches - 1 to 2 men on equipment, or 1 crew leader and 3 to 8 men with handtools.

Typical crew: Grass - 1 crew leader, 6 to 20 men plowing, harrowing, fertilizing, digging sprigs, hauling sprigs, scattering sprigs, disking, seeding and watering.

Typical crew: Riprap - 1 crew leader and 6 to 20 men hauling and placing riprap.

(1) Reference- FM 5-35, Table 16-42

TABLE B-3

EMERGENCY LABOR REQUIREMENTS - GENERAL EXCAVATION (1)

| WORK ELEMENT DESCRIPTION | UNIT | MAN-DAYS PER UNIT | | |
|---|---|---|---|---|
| | | ADVERSE CONDITION | AVERAGE CONDITION | FAVORABLE CONDITION |
| Machine Work: | | | | |
| Excavating (no trim nor handwork) | 1000 CY | 25 | 12 | 6 |
| Loading | 1000 CY | 9.0 | 4.5 | 2.0 |
| Hauling | 1000 yard miles | 5.2 | 3.1 | 1.4 |
| Spreading | 1000 CY | 4.9 | 3.0 | 1.5 |
| Backfilling | 1000 CY | 9 | 6 | 3 |
| Compacting | 1000 CY | 12 | 8 | 4 |
| Grading | 1000 CY | 1.6 | 0.8 | 0.4 |
| Handwork: | | | | |
| Excavating | CY | 1.2 | 0.7 | 0.3 |
| Loading | CY | 0.8 | 0.4 | 0.2 |
| Spreading | CY | 0.18 | 0.12 | 0.06 |
| Backfilling | CY | 0.35 | 0.20 | 0.10 |
| Compacting | CY | 0.35 | 0.35 | 0.15 |
| Shoring Walls of Excavation | 1000 SF | 40 | 24 | 8 |

Typical crew: Machine work - 1 crew leader, 2 men excavating, 2 to 6 men on hauling equipment, 1 man on spreading and backfilling equipment; 1 man on compacting equipment, and 1 man on grading equipment.

Typical crew: Handwork - 1 crew leader, 2 to 10 men excavating, loading, spreading backfilling, compacting, trimming, and fine grading.

Typical crew: Shoring - 2 or more men.

(1) Reference- FM 5-35, Table 16-20.

TABLE B-4

INVENTORY OF RESOURCES - DISTRICT LEVEL

| Name of Resource | Type of Resource | Address | Phone Number |
|---|---|---|---|
| Brisson Pump Company | Pump Distributor | 2359 E. Cowern Place<br>N. St. Paul, Minnesota 55109 | (612) 777-3317 |
| Tecumseh Products Company | Pump Distributor | P.O. Box 355<br>223 Curtis Street<br>Delaware, Ohio 43015 | (614) 369-9656 |
| Kasten Schmidt Equipment Systems | Pump Distributor | 455 Whitrock Avenue<br>Wisconsin Rapids, Wisconsin 54494 | (715) 423-9221 |
| The Crisafulli Pump Company, Inc. | Pump Distributor | Box 1051<br>Glendive, Montana 59330 | (406) 345-3393 |
| Gator Pump, Inc. | Pump Distributor | P.O. Box 57<br>302 Corrigan<br>Brownwood, Texas 76801 | 1-800-351-1463 |
| Cherne Industries, Inc. | Sewer Plugs/Pipe Stoppers | 5701 S. County Road 18<br>Minneapolis, Minnesota 55436 | (612) 933-5501 |
| NB Products | Sewer Plugs/Pipe Stoppers | 35 Bevlah Road<br>New Britain, Pa 18901 | (215) 345-1879 |
| Goodyear Tire and Rubber Company | Sewer Plugs/Pipe Stoppers | 5100 West 35th Street<br>Minneapolis, Minnesota | (612) 927-7381 |
| Carlson Equipment Company | Sewer Plugs/Pipe Stoppers | 1380 W. County Road C<br>St. Paul, Minnesota 55113 | (612) 633-8171 |

TABLE B-4 (Continued)

INVENTORY OF RESOURCES - DISTRICT LEVEL

| Name of Resource | Type of Resource | Address | Phone Number |
|---|---|---|---|
| Mac Katz Bag Co., Inc. (includes polythylene sheeting) | Sandbags | P.O. Box 1666<br>Indianapolis, Indiana<br>46206-1666 | (317) 635-9561 |
| Independent Manufacturers Marketing Service | Sandbags | 1543 Holton Street<br>St. Paul, Minnesota 55108 | (612) 644-2007 |
| Berg Bag Company | Sandbags | 410 3rd Avenue North<br>Minneapolis, Minnesota 55401 | (612) 922-3286 |
| Northwest Bag Corporation | Sandbags | 400 3rd Avenue North<br>Minneapolis, Minnesota 55401 | (612) 379-0305 |
| Volm Bag Company, Inc. | Sandbags | 2200 Mary Hills Drive<br>Golden Valley, | (612) 588-3232 |
| Minneapolis Bag & Barrel Company | Sandbags | Lumber Exchange Building<br>Minneapolis, Minnesota | (612) 333-1459 |
| Central Bag Company | Sandbags | 1323 W. 13th St. P.O. Box 4044<br>Kansas City, Missouri 64101 | (816) 471-0388 |
| Dan-Dee Equipment, Inc. | Sandbagging Equipment | P.O. Box 125<br>Honey Creek, Wisconsin 53138 | (414) 534-3138 |
| Bemis Company, Inc.<br>Packaging Service | Sandbagging Equipment | 315 27th Ave N.E.<br>Minneapolis, Minnesota 55418 | - |

TABLE B-5
INVENTORY OF LOCAL CONTRACTORS AND VENDORS - PROJECT OFFICE LEVEL

| Name of Contractor/Vendor | Type of Service | Address | Phone Number |
|---|---|---|---|
| Crosby Construction Company | Contractor | Rt. 4<br>Montevideo, Minnesota 56265 | (612) 269-6685 |
| Larson Gravel Company | Contractor | Rt. 1<br>Milan, Minnesota 56262 | (612) 793-6728 |
| Mooneys, Inc. | Contractor | P.O. Box 128<br>Granite Falls, Minnesota 56241 | (612) 564-4411 |
| Hasslen Construction Co., Inc. | Contractor | P.O. Box 157<br>Ortonville, Minnesota 56278 | (612) 839-2529 |
| Standard Lumber Company | Vendor | Parkview Addn.<br>Montevideo, Minnesota 56265 | (612) 269-5552 |
| Central Contractors Supply | Vendor | High Av & Lakeland Dr<br>Willmar, Minnesota 56201 | (612) 235-5151 |
| Watson Lumber Company | Vendor | Hwy. 759 & Central Ave.<br>P.O. Box 100<br>Watson, Minnesota 56295 | (612) 269-6114 |

Emergency Equipment Located at LQP Maintenance Building

| Equipment | Quantity |
|---|---|
| D-6 Dozer | 1 |
| Tractor w/ Front Loader | 2 |
| Pickup Truck | 2 |
| Van, 7 pass. | 1 |
| Portable Water Pump | 2 |
| Portable Water Sprayer | 1 |
| Fire Extinguishers | 7 |
| Chain Saws | 4 |
| Axes | 3 |
| Shovels | 4 |
| Rakes | 2 |
| Walkie Talkies | 2 |
| Hard Hats | 5 |
| First Aid Kits | 3 |
| Pairs of Goggles | 6 |
| Pairs of Gloves | 12 |
| Boat, 14 ft. alum. | 1 |

TABLE B-5 (CONTINUED)
INVENTORY OF LOCAL CONTRACTORS AND VENDORS - PROJECT OFFICE LEVEL

Emergency Equipment Located at Hwy. 75 Dam Storage Building

| Equipment | Quantity |
|---|---|
| Tractor w/Loader | 1 |
| Fire Extinguisher | 1 |
| Shovel | 1 |
| Hard Hats | 2 |
| First Aid Kit | 1 |
| Pairs of Goggles | 2 |
| Pairs of Gloves | 3 |
| Sandbags | 1000 |

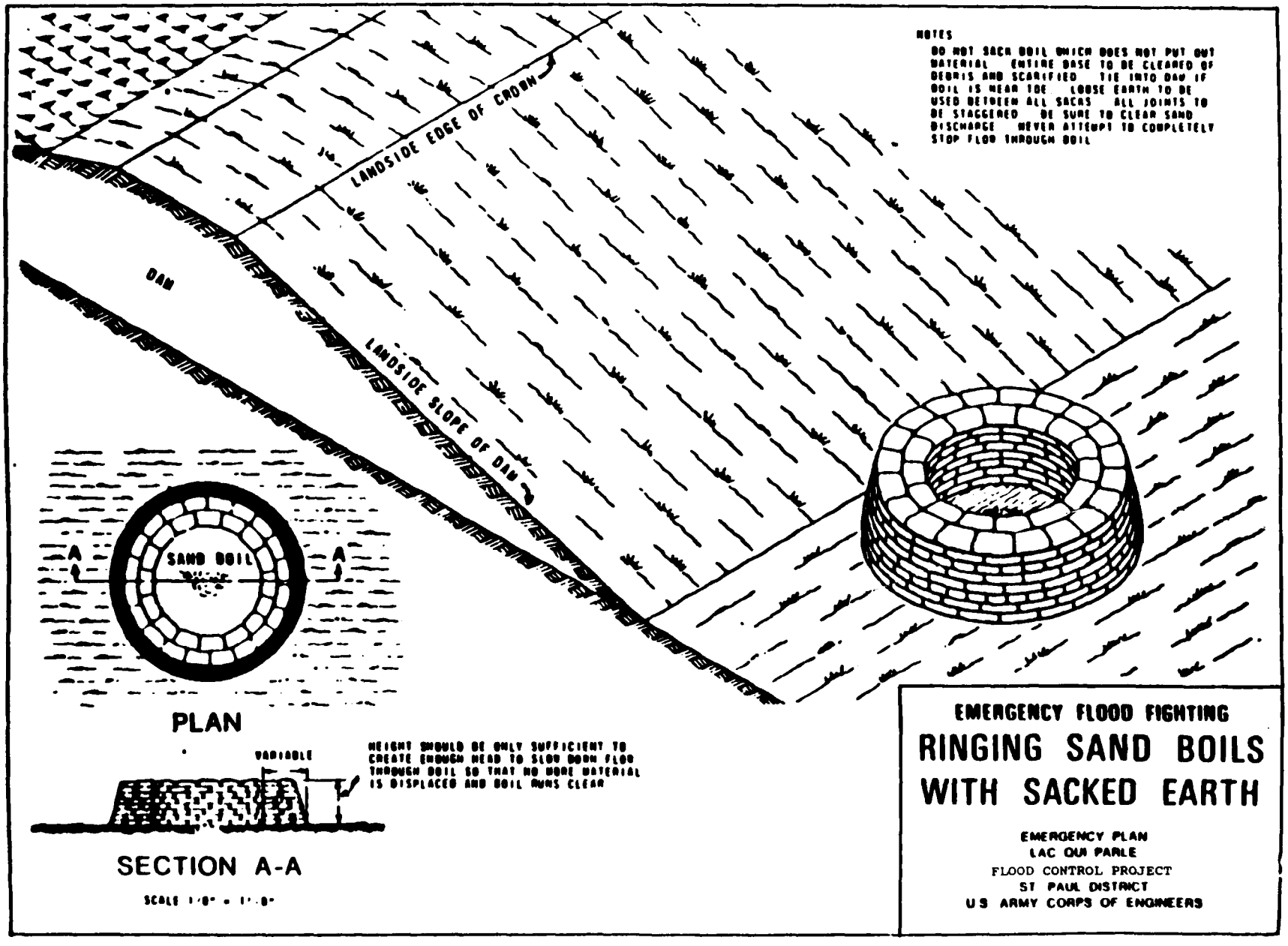
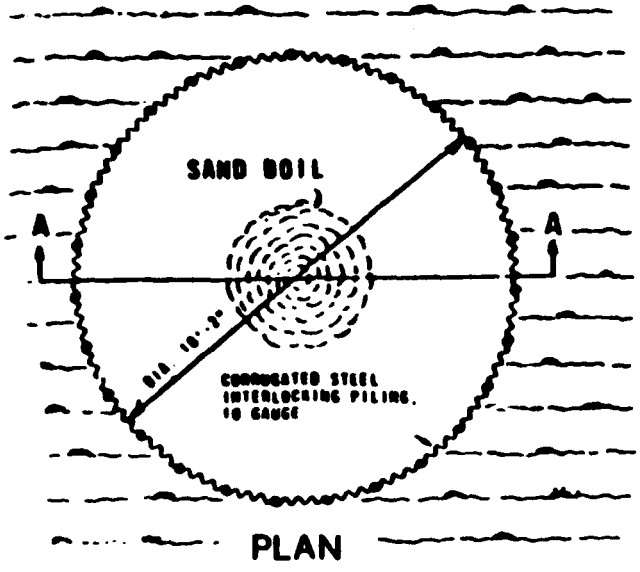

NOTES
DO NOT SACK BOIL WHICH DOES NOT PUT OUT MATERIAL ENTIRE BASE TO BE CLEARED OF DEBRIS AND SCARIFIED TIE INTO DAM IF BOIL IS NEAR TOE LOOSE EARTH TO BE USED BETWEEN ALL SACKS ALL JOINTS TO BE STAGGERED BE SURE TO CLEAR SAND DISCHARGE NEVER ATTEMPT TO COMPLETELY STOP FLOW THROUGH BOIL
LANDSIDE EDGE OF CROWN
DAM
LANDSIDE SLOPE OF DAM
SAND BOIL
A
A
PLAN
VARIABLE
HEIGHT SHOULD BE ONLY SUFFICIENT TO CREATE ENOUGH HEAD TO SLOW DOWN FLOW THROUGH BOIL SO THAT NO MORE MATERIAL IS DISPLACED AND BOIL RUNS CLEAR
SECTION A-A
SCALE 1/8" = 1'-0"
EMERGENCY FLOOD FIGHTING
RINGING SAND BOILS WITH SACKED EARTH
EMERGENCY PLAN
LAC QUI PARLE
FLOOD CONTROL PROJECT
ST PAUL DISTRICT
U S ARMY CORPS OF ENGINEERS

PLATE B-1

# EMERGENCY FLOOD FIGHTING
# RINGING SAND BOILS WITH STEEL PILING

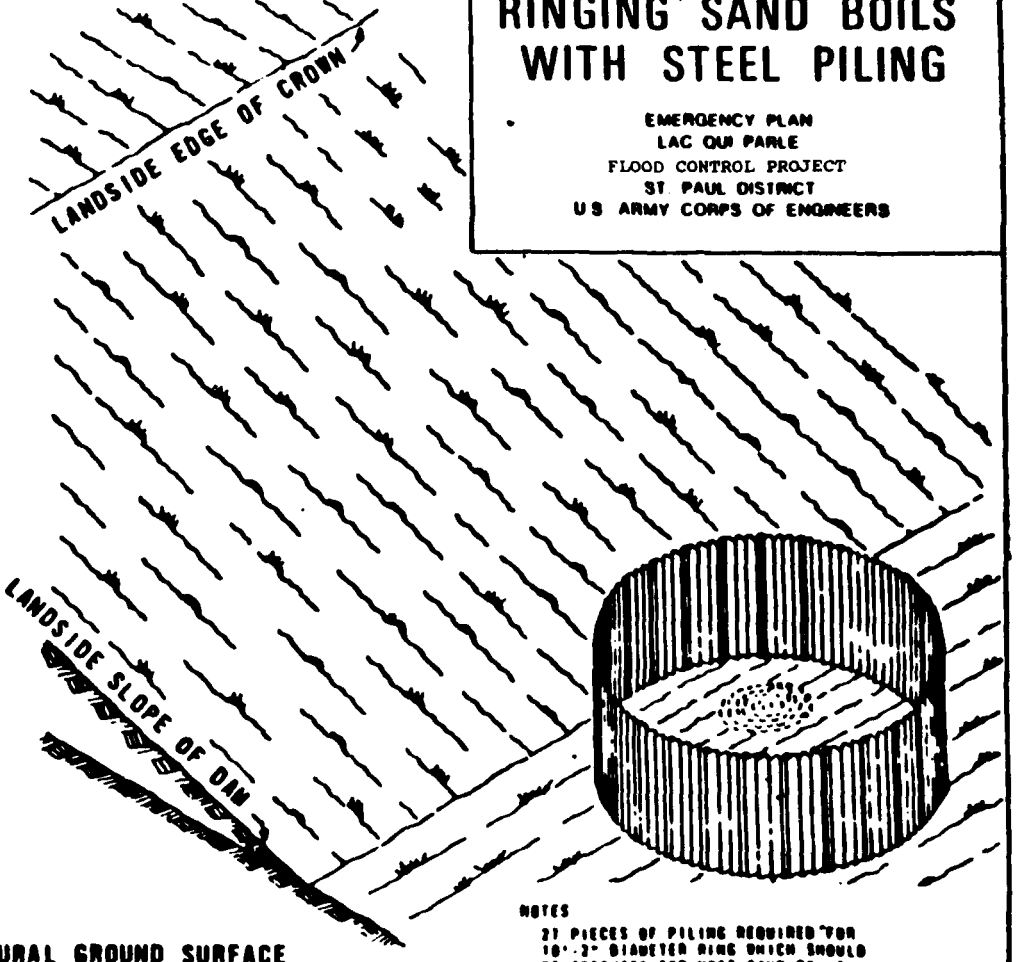
EMERGENCY PLAN
LAC QUI PARLE
FLOOD CONTROL PROJECT
ST. PAUL DISTRICT
U.S. ARMY CORPS OF ENGINEERS

NOTE
DRIVING CAPS WILL BE USED. DRIVING MAY BE EFFECTED EITHER BY MECHANICAL OR HAND METHOD.




PLAN


SECTION A-A




NOTES
21 PIECES OF PILING REQUIRED FOR 10'-2" DIAMETER RING WHICH SHOULD BE ADEQUATE FOR MOST SAND BOILS
DO NOT RING BOIL WHICH DOES NOT PUT OUT MATERIAL
ENTIRE AREA TO BE CLEARED OF DEBRIS
BE SURE TO CLEAR SAND DISCHARGE
NEVER ATTEMPT TO COMPLETELY STOP FLOW THROUGH BOIL

PLATE B-2

# TIME REQUIRED TO CONSTRUCT SANDBAG RINGS OF VARIOUS SIZES

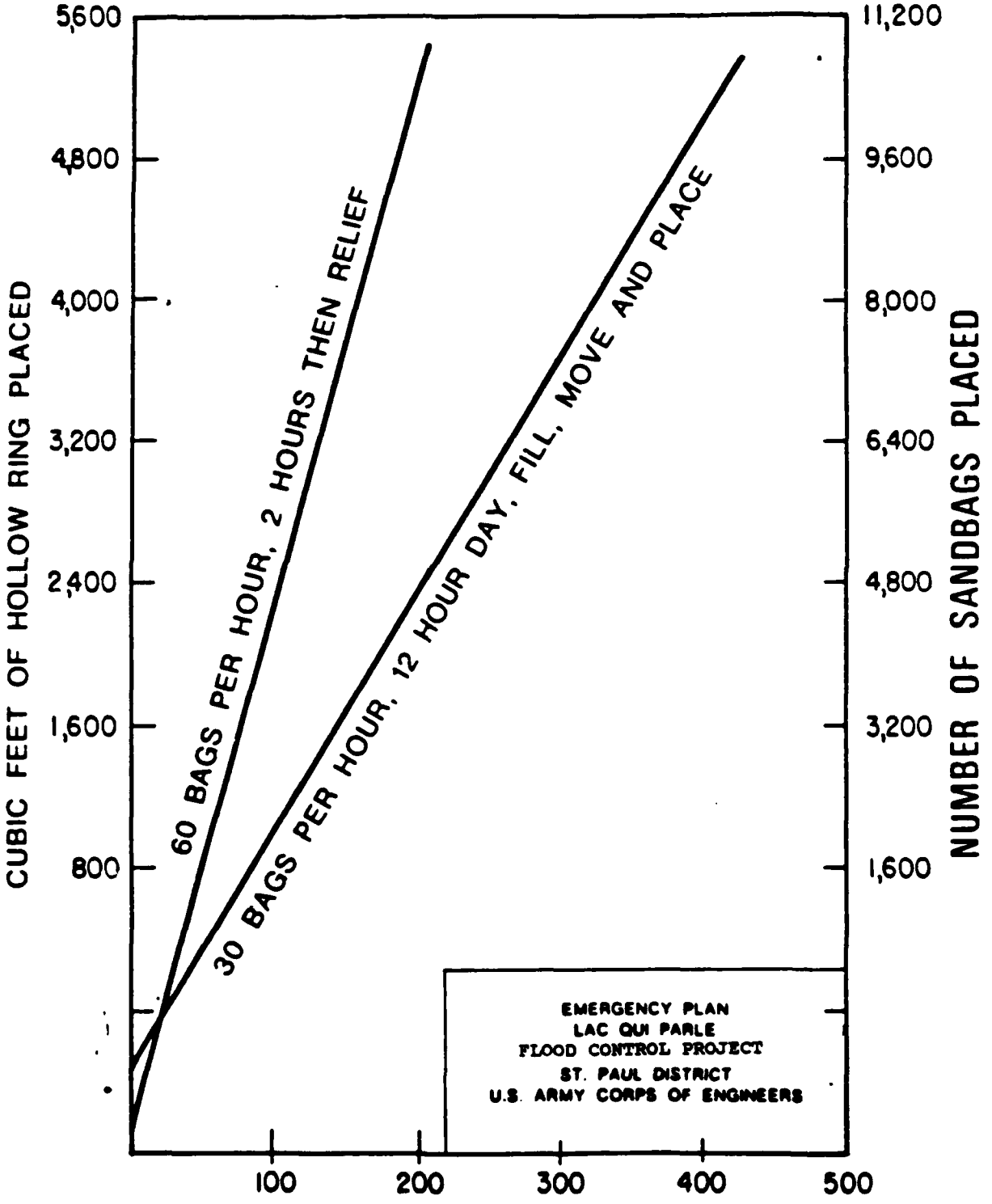
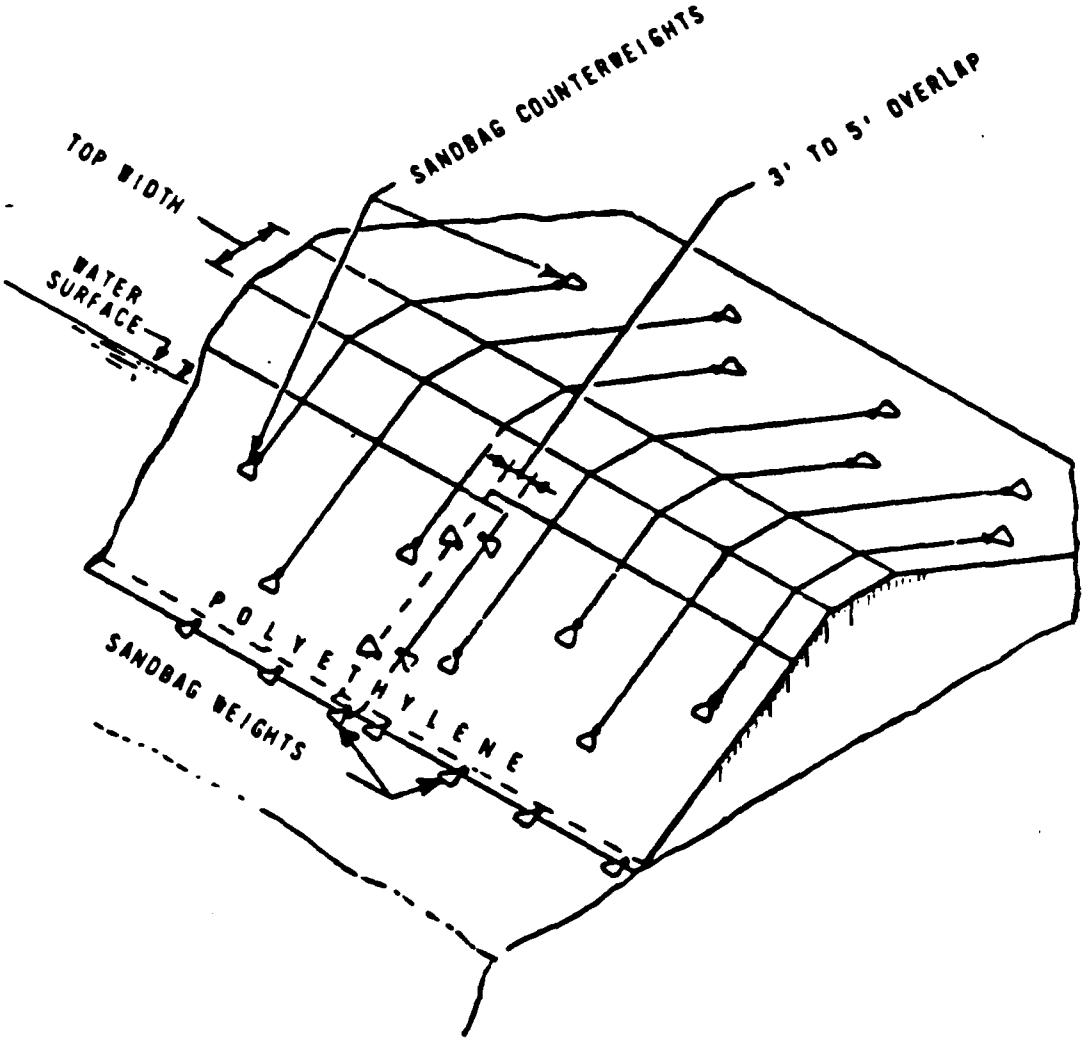



PLATE B-3




EMERGENCY FLOOD FIGHTING

# PLACEMENT OF POLYETHYLENE SHEETING IN THE WET

EMERGENCY PLAN
LAC QUI PARLE
FLOOD CONTROL PROJECT
ST. PAUL DISTRICT
U.S. ARMY CORPS OF ENGINEERS

PLATE B-4

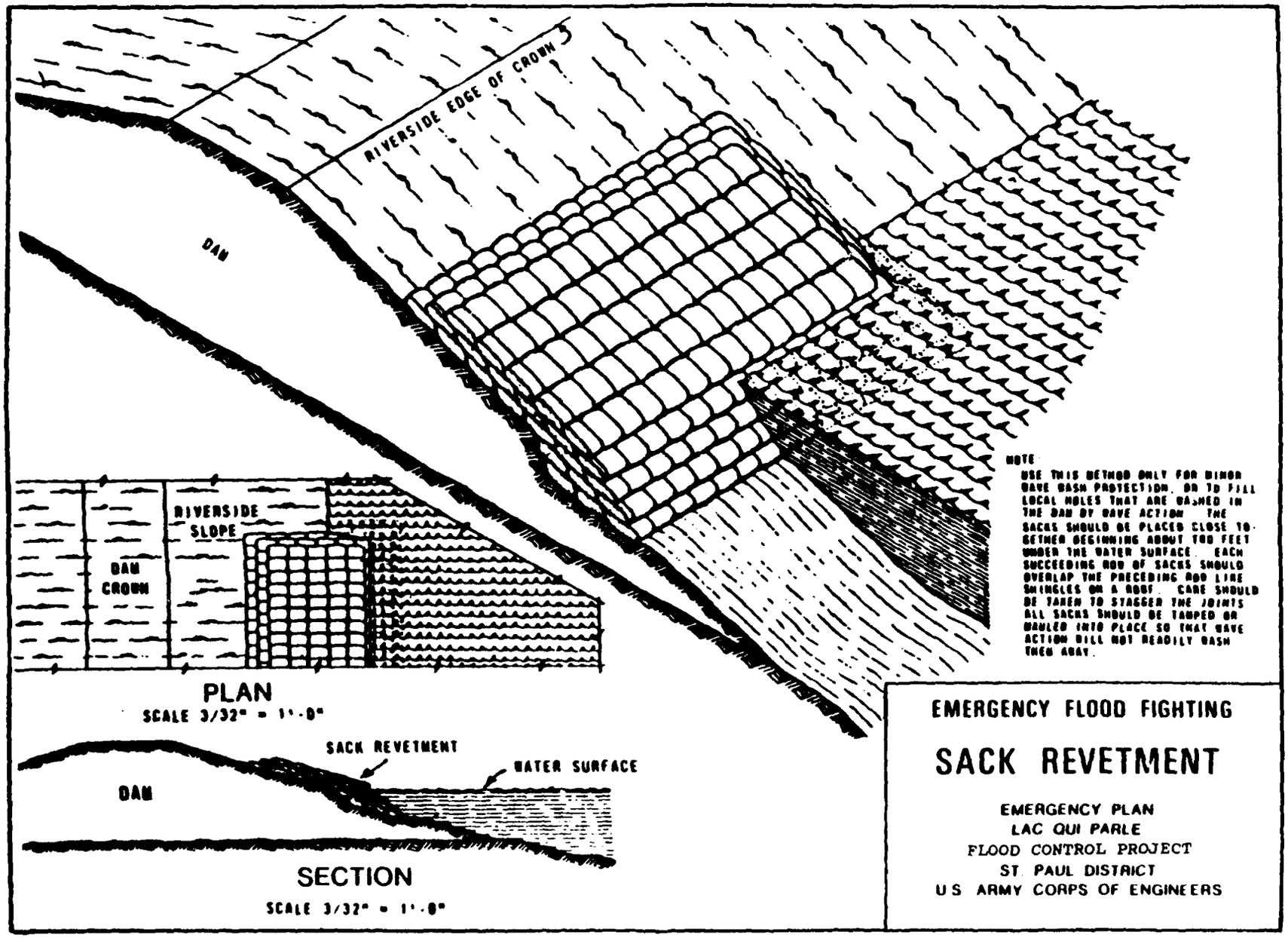
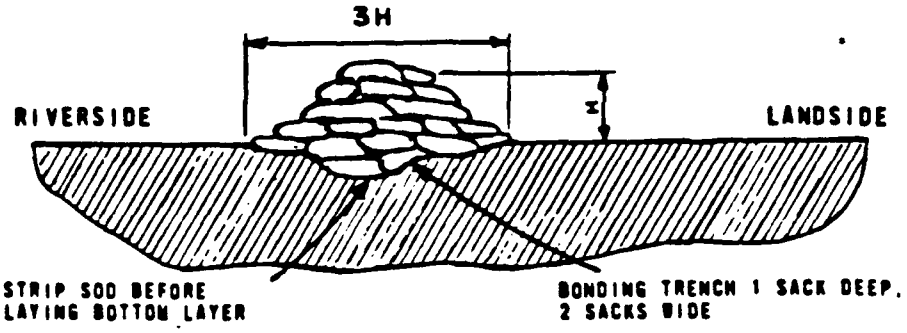

RIVERSIDE EDGE OF CROWN
DAM
RIVERSIDE SLOPE
DAM CROWN
PLAN
SCALE 3/32" = 1'-0"
SACK REVETMENT
WATER SURFACE
DAM
SECTION
SCALE 3/32" = 1'-0"
NOTE
USE THIS METHOD ONLY FOR MINOR WAVE WASH PROTECTION, OR TO FILL LOCAL HOLES THAT ARE WASHED IN THE DAM BY WAVE ACTION. THE SACKS SHOULD BE PLACED CLOSE TOGETHER BEGINNING ABOUT TWO FEET UNDER THE WATER SURFACE. EACH SUCCEEDING ROW OF SACKS SHOULD OVERLAP THE PRECEDING ROW LIKE SHINGLES ON A ROOF. CARE SHOULD BE TAKEN TO STAGGER THE JOINTS. ALL SACKS SHOULD BE TAMPED OR HANDLED INTO PLACE SO THAT WAVE ACTION WILL NOT READILY WASH THEM AWAY.
EMERGENCY FLOOD FIGHTING
SACK REVETMENT
EMERGENCY PLAN
LAC QUI PARLE
FLOOD CONTROL PROJECT
ST. PAUL DISTRICT
U.S. ARMY CORPS OF ENGINEERS

PLATE B-5




SECTION

NOTE:

ALTERNATE DIRECTION OF SACKS WITH BOTTOM LAYER PARALLEL TO FLOW, NEXT LAYER PERPENDICULAR TO FLOW, ETC.

LAP UNFILLED PORTION UNDER NEXT SACK.

TYING OR SEWING SACKS NOT NECESSARY.

TAMP THOROUGHLY IN PLACE.

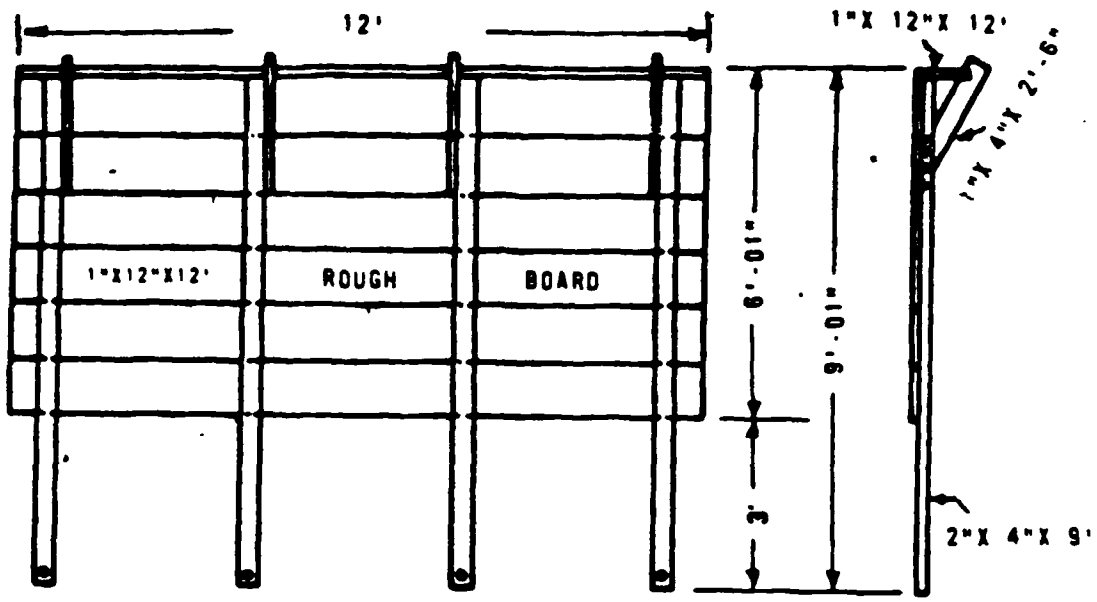
SACKS SHOULD BE APPROXIMATELY 1/2 FULL OF SAND.

METHOD OF LAPPING SACKS

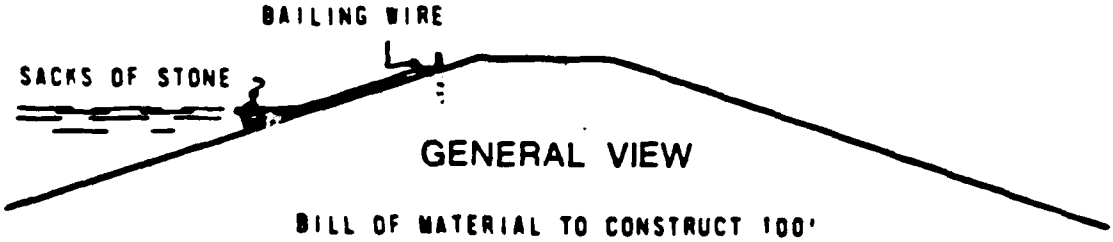
EMERGENCY FLOOD FIGHTING

# SANDBAG BARRIER

EMERGENCY PLAN
LAC QUI PARLE
FLOOD CONTROL PROJECT
ST. PAUL DISTRICT
U.S. ARMY CORPS OF ENGINEERS




PLAN ELEVATION




GENERAL VIEW

BILL OF MATERIAL TO CONSTRUCT 100'

56 PCS. 1"X 12"X 12'  32 PCS. 1"X 4"X 2'-6"
32 PCS. 2"X 4"X 9'  32 PCS. 2"X 4"X 2'

PERSONNEL REQUIRED FOR PLACING PLANKS -
4.2 - 5.8 MAN HOURS PER 100 SQUARE FEET.

EMERGENCY FLOOD FIGHTING

# TYPE OF MOVABLE WAVE WASH PROTECTION

EMERGENCY PLAN
LAC QUI PARLE
FLOOD CONTROL PROJECT
ST. PAUL DISTRICT
U.S ARMY CORPS OF ENGINEERS

PLATE B-7

ENGINEERING PROPERTIES OF VARIOUS SOIL TYPES [1].

| TYPICAL NAMES OF SOIL GROUPS | GROUP SYMBOLS | IMPORTANT ENGINEERING PROPERTIES | | | WORKABILITY AS A CONSTRUCTION MATERIAL |
|---|---|---|---|---|---|
| | | PERMEABILITY WHEN COMPACTED | SHEAR STRENGTH WHEN COMPACTED AND SATURATED | COMPRESSIBILITY WHEN COMPACTED AND SATURATED | |
| WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES | GW | PERVIOUS | EXCELLENT | NEGLIGIBLE | EXCELLENT |
| POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES | GP | VERY PERVIOUS | GOOD | NEGLIGIBLE | GOOD |
| SILTY GRAVELS, POORLY-GRADED GRAVEL-SAND-SILT MIXTURES | GM | SEMIPERVIOUS TO IMPERVIOUS | GOOD | NEGLIGIBLE | GOOD |
| CLAYEY GRAVELS, POORLY-GRADED GRAVEL-SAND-CLAY MIXTURES | GC | IMPERVIOUS | GOOD TO FAIR | VERY LOW | GOOD |
| WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES | SW | PERVIOUS | EXCELLENT | NEGLIGIBLE | EXCELLENT |
| POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES | SP | PERVIOUS | GOOD | VERY LOW | FAIR |
| SILTY SANDS, POORLY-GRADED SAND-SILT MIXTURES | SM | SEMIPERVIOUS TO IMPERVIOUS | GOOD | LOW | FAIR |
| CLAYEY SANDS, POORLY-GRADED SAND-CLAY MIXTURES | SC | IMPERVIOUS | GOOD TO FAIR | LOW | GOOD |
| INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS WITH SLIGHT PLASTICITY | ML | SEMIPERVIOUS TO IMPERVIOUS | FAIR | MEDIUM | FAIR |
| INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS | CL | IMPERVIOUS | FAIR | MEDIUM | GOOD TO FAIR |
| ORGANIC SILTS AND ORGANIC SILT CLAYS OF LOW PLASTICITY | OL | SEMIPERVIOUS TO IMPERVIOUS | POOR | MEDIUM | FAIR |
| INORGANIC SILTS MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS | MH | SEMIPERVIOUS TO IMPERVIOUS | FAIR TO POOR | HIGH | POOR |
| INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS | CH | IMPERVIOUS | POOR | HIGH | POOR |
| ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY | OH | IMPERVIOUS | POOR | HIGH | POOR |
| PEAT AND OTHER HIGHLY ORGANIC SOILS | PT | --- | --- | --- | --- |

1. Reference-Earth Manual, Bureau of Reclamation, Second Edition.

USES OF VARIOUS SOIL TYPES 1.

| TYPICAL NAMES OF SOIL GROUPS | GROUP SYMBOLS | RELATIVE DESIRABILITY FOR VARIOUS USES (NO. 1 IS CONSIDERED THE BEST) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ROLLED EARTHFILL DAMS | | | CANAL SECTIONS | | FOUNDATIONS | | ROADWAYS | | |
| | | HOMOGENEOUS EMBANKMENT | CORE | SHELL | EROSION RESISTANCE | COMPACTED EARTH LINING | SEEPAGE IMPORTANT | SEEPAGE NOT IMPORTANT | FILLS: FROST HEAVE NOT POSSIBLE | FILLS: FROST HEAVE POSSIBLE | SURFACING |
| WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES | GW | --- | --- | 1 | 1 | --- | --- | 1 | 1 | 1 | 3 |
| POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES | GP | --- | --- | 2 | 2 | --- | --- | 3 | 3 | 3 | --- |
| SILTY GRAVELS, POORLY-GRADED GRAVEL-SAND-SILT MIXTURES | GM | 2 | 4 | --- | 4 | 4 | 1 | 4 | 4 | 9 | 5 |
| CLAYEY GRAVELS, POORLY-GRADED GRAVEL-SAND-CLAY MIXTURES | GC | 1 | 1 | --- | 3 | 1 | 2 | 6 | 5 | 5 | 1 |
| WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES | SW | --- | --- | 3 IF GRAVELLY | 6 | --- | --- | 2 | 2 | 2 | 4 |
| POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES | SP | --- | --- | 4 IF GRAVELLY | 7 IF GRAVELLY | --- | --- | 5 | 6 | 4 | --- |
| SILTY SANDS, POORLY-GRADED SAND-SILT MIXTURES | SM | 4 | 5 | --- | 8 IF GRAVELLY | 5 EROSION CRITICAL | 3 | 7 | 8 | 10 | 6 |
| CLAYEY SANDS, POORLY-GRADED SAND-CLAY MIXTURES | SC | 3 | 2 | --- | 5 | 2 | 4 | 8 | 7 | 6 | 2 |
| INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS WITH SLIGHT PLASTICITY | ML | 6 | 6 | --- | --- | 6 EROSION CRITICAL | 6 | 9 | 10 | 11 | --- |
| INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS | CL | 5 | 3 | --- | 9 | 3 | 5 | 10 | 9 | 7 | 7 |
| ORGANIC SILTS AND ORGANIC SILT CLAYS OF LOW PLASTICITY | OL | 8 | 8 | --- | --- | 7 EROSION CRITICAL | 7 | 11 | 11 | 12 | --- |
| INORGANIC SILTS MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS | MH | 9 | 9 | --- | --- | --- | 8 | 12 | 12 | 13 | --- |
| INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS | CH | 7 | 7 | --- | 10 | 8 VOLUME CHANGE CRITICAL | 9 | 13 | 13 | 8 | --- |
| ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY | OH | 10 | 10 | --- | --- | --- | 10 | 14 | 14 | 14 | --- |
| PEAT AND OTHER HIGHLY ORGANIC SOILS | PT | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |

For a landside berm a GW or GP soil would work best, if available. If such a soil is not readily available, and SP or SW soil could be used (if gravelly) for the lower layer of the blanket with a coarse gravel or rock blanket on top. Depending upon the site, adequate material may not be available. If materials for emergency repair of the dam are not readily available at the site, it may be desirable to haul the materials in advance and stockpile them in a safe location with proper protection.

1. Reference - Earth Manual, Bureau of Reclamation, Second Edition.

PLATE B-9

# EMERGENCY NOTIFICATION SUBPLAN

## APPENDIX C

to

## EMERGENCY PLAN

for

## LAC QUI PARLE FLOOD CONTROL PROJECT

OCTOBER 1988

TABLE OF CONTENTS



LIST OF TABLES



LIST OF FIGURES

EMERGENCY NOTIFICATION SUBPLAN
LAC QUI PARLE DAM AND RESERVOIR

C-1. Introduction

Conditions affecting operation of Lac qui Parle flood control project could result in a hazard to life and/or property due to high reservoir levels or sudden release of large volumes of water. Prompt issuance of appropriate notifications is essential for minimizing hazards to life and property.

a. Purpose

This subplan implements a portion of the Corps program to prepare emergency plans for all Corps dams. It establishes procedures for issuing notifications of impending and existing emergencies affecting the operation and safety of Lac qui Parle flood control project.

b. Scope

This subplan specifies notifications and other actions to be taken upon declaration of a Pre-Emergency or Emergency condition. Notifications and actions specified are those necessary for:

(1) Ensuring safety.

(2) Vacating project areas where emergency operations and repairs may be conducted.

(3) Internal coordination of Corps of Engineers activities.

(4) Coordination with non-Federal units of government and other Federal agencies.

c. Applicability

This subplan is applicable to all Corps elements and field offices concerned with operation of Lac qui Parle flood control project.

C-2. Definitions

a. Pre-Emergency

A "Pre-Emergency" condition is one in which some impending or existing threat to the safe operation of the dam or

reservoir is identified but no significant hazard to life or property is expected to occur.

b. Emergency

An "Emergency" condition is one in which the occurrence of a significant hazard to life and/or property is possible or certain to occur. Conditions justifying declaration of an Emergency condition may be imminent or longer term.

c. Park Manager

The term "Park Manager" means the individual in charge at the Lac qui Parle Dam project site.

d. Western Flood Control Project Office

The term "Western Flood Control Project Office" means the person in charge of the project office.

e. District

The term "District" identifies one of the following elements depending upon which is appropriate for the situation at hand.

(1) Emergency Operation Center. Provides a 24-hour telephone contact with District Office. Responsible for contacting the Dam Safety Officer, the Commander/District Engineer, and NCD. Also responsible for matters involving national security, disasters, and mobilization.

(2) Project Operations Branch. Responsible for identifying a person-in-charge of the pre-emergency or emergency situation. Responsible for keeping the Dam Safety Officer informed of the pre-emergency or emergency situation. Also, responsible for matters involving normal dam operations and/or other matters not covered by the other District elements.

(3) Dam Safety Officer. The Dam Safety Officer must be kept informed of all pre-emergency or emergency situations. Responsible for identifying and/or providing the necessary engineering or technical support required for the pre-emergency or emergency situation.

(4) Water Control Center. Part of Hydrology Section in Geotechnical, Hydraulics and Hydrologic Engineering Branch. Responsible for matters involving reservoir regulation.

(5) Geotechnical Design Section. A section in Geotechnical, Hydraulics and Hydrologic Engineering Branch. Responsible for matters involving the structural integrity of the dam.

(6) Design Branch. Responsible for matters involving the struc- tural integrity of the outlet structures.

(7) Project Management Branch. Responsible for management support.

(8) Planning Division. Responsible for management support, and matters involving envirionmental analysis and cultural resources.

C-3. Basis of Activation

This subplan is to be activated immediately upon declaration of a Pre-Emergency or Emergency Condition.

C-4. Communications

a. Corps Offices

(1) Normal

Communications between the District and Park Manager, are normally by radio. Radios at the project administration office and District's Emergency Operating Center will be manned on a 24-hour basis during all flood emergencies and whenever a Pre-Emergency or Emergency condition is in effect. (Office and home phone numbers of key Corps personnel are listed in Table C-1).

(2) Back-Up

The telephone communications network between the District Office, project administration office and Western Flood Control Project office will be used to backup radio communications. Telephones at each office will be manned as required during all flood emergencies and whenever a Pre-Emergency or Emergency condition is in effect and radio service is disrupted. Information on radio frequencies and call letters for key contacts are listed in Table A-1.

(3) Emergency

During a situation when both radio and telephone communications between the District Office and project area are

lost, others equipped with radio or telephone facilities will be called on for assistance. Those to whom application for assistance may be made are identified in Table C-1 along with information for telephone.

b. Other Parties

(1) Normal

Communications with other parties will normally be by telephone. Office and home phone numbers of key contacts are listed in Table C-2.

(2) Back-Up

Communications with other parties will be by radio in the event telephone service is disrupted. The table also lists those parties which can be requested to forward notifications to offices lacking radio equipment.

C-5. Internal Notifications Required

a. Offices to be Notified

Notification of the declaration of all Pre-Emergency and Emergency conditions will be given to Park Manager, Western Flood Control Project Office, St. Paul District, and the North Central Division. The Office of the Chief of Engineers EOC will also be notified. The internal notifications required for various emergency conditions are listed in Table C-3. Information on contacting each party is listed in Table C-1.

b. Timing of Notifications

Notifications are to be made as soon as possible after declaration of a Pre-Emergency or Emergency condition.

c. Content of Notification Message

Notifications are to include the key information needed as a basis for decision making and/or action including, as appropriate and to the extent possible, the following:

(1) Description of Situation

(a) Nature and severity of problem(s).

(b) Current and predicted reservoir conditions including water elevation, inflow and discharge.

(c) Current and forecasted weather conditions.

(2) Action Planned or Underway

(a) Type of corrective actions.

(b) Estimated time to complete corrective actions.

(c) Outlook for success.

(d) Assistance required/being furnished.

(e) Potential complications.

(f) Recommended evacuation.

(3) Other

(a) Staff at dam site.

(b) Visitors at project.

(c) Road conditions.

C-6. External Notifications Required

a. Parties to be Notified

Parties to be notified under various emergency conditions are listed in Table C-3. Information on contacting each party is listed in Table C-2.

b. Timing of Notifications

Notifications shall be made as soon as possible to allow the maximum time for evacuation and/or other protective action. Elevations and other criteria for notification shown in Table C-3 are points at which inundation or other hazard occurs. Notifications should precede occurrence of such conditions by the maximum possible time.

c. Content of Notification Message

Notification messages are to include a description of the nature of impending or existing hazard, potential timing of its occurrence, and recommendations for evacuation and other action (needed evacuation on project lands managed by the Corps will be directed rather than recommended).

C-7. Pre-Emergency Actions

a. Park Manager

For a Park Manager declared Pre-Emergency or suspect Pre-Emergency situation, the Park Manager must notify the Western Flood Control Project Office in accord with paragraph C-5, Table C-1 and Figure C-1.

If contact with the Western Flood Control Project Office cannot be made, contact the Dam Safety Officer, Project Operations Branch, and Emergency Operations Center as shown in Table C-1 and Figure C-1.

b. Western Flood Control Project Office

Evaluate the situation and declare a Pre-Emergency condition if warranted.

Notify Dam Safety Officer, Project Operations Branch, and Emergency Operations Center in accord with paragraph C-5, Table C-1 and Figure C-1.

Provide assistance as needed to Park Manager and District Office.

c. District

(1) Dam Safety Officer

The Dam Safety Officer is to be kept informed of all conditions of the Pre-Emergency situation.

Responsible for identifying and/or providing the necessary engineering or technical support required to resolve the pre-emergency situation.

Evaluate the situation and declare a pre-emergency condition if warranted.

Notify the North Central Division Dam Safety Officer in accord with paragraph C-5 if Pre-Emergency condition was declared by the Park Manager, Western Flood Control Project Office, or District Office.

Notify the Dam Safety Committee, the Emergency Operations Center and the Project Operations Branch of the situation.

(2) Project Operations Branch

Must be kept informed of all pre-emergency situations.

Responsible for identifying a person-in-charge of the pre-emergency situation. Also, responsible for matters involving normal Dam operations and/or any other matters not covered by other District elements.

Responsible for contacting the Dam Safety Officer for engineering and technical assistance and keeping him informed of the situation. Also, contact the Emergency Operations Center and keep them informed of the situation.

Evaluate the situation and declare a pre-emergency condition if warranted.

Provide needed assistance and/or instructions to the Western Flood Control Project Office, Park Manager and person-in-charge of the Pre-Emergency situation.

(3) Emergency Operations Center

Twenty four (24) hour telephone service.

Must be kept informed of all pre-emergency situations.

Responsible for contacting Dam Safety Officer, Project Operations Branch, District Engineer, Public Affairs, and the NCD Emergency Manager.

Responsible for matters involving National Security, Disasters, and Mobilization. Provide emergency response in accordance with ER 500-1-1, National Disaster Procedures.

Evaluate the situation and declare a pre-emergency condition if warranted.

(4) Others

The District personnel listed under this category in Table C-1 are only to be contacted if none of the above District Elements could be reached.

Evaluate the Pre-Emergency conditions and declare a Pre-Emergency condition if warranted. Notify the Dam Safety Officer, the Emergency Operations Center and the Project Operations Branch as soon as possible.

If the Project Operations Branch cannot be contacted, appoint a temporary person-in-charge of the Pre-Emergency situation.

Provide needed assistance and/or instructions to Western Flood Control Project Office, Park Manager and person-in-charge of the Pre-Emergency situation.

C-8. Emergency Actions

a. Park Manager

(1) For a Park Manager declared Emergency or suspect Emergency situation, the Park Manager must notify the Western Flood Control Project Office in accord with paragraph C-5, Table C-1, and Figure C-1.

If contact with the Western Flood Control Project Office cannot be made, contact the Dam Safety Officer, Project Operations Branch, and Emergency Operations Center as shown in Table C-1 and Figure C-1.

(2) Cancel normal work schedule and provide for 24-hour duty as needed.

(3) Access project areas which are or may become unsafe including but not limited to:

(a) Reservoir water surface.

(b) Day use and recreational areas within project boundaries including those managed by others.

(4) Identify areas required for conduct of emergency operations and repairs including any necessary access routes.

(5) Take action to notify and evacuate areas which are unsafe, potentially unsafe, or where emergency operations and repair work may be carried out including, as appropriate:

(a) Directing evacuation of affected project areas managed by the Corps.

(b) Closing project roads to incoming traffic.

(c) Moving equipment to safe areas.

(6) Request assistance as needed in carrying out items (5)(a) and (5)(b) from agencies listed in Table C-2.

(7) Assume District responsibilities for notifications if Emergency condition was declared by Park Manager.

(8) Verify appropriate warnings if announced over local radio and television.

b. Western Flood Control Project Office

Evaluate the situation and declare a Emergency condition if warranted.

Notify Dam Safety Officer, Project Opertions Branch, and Emergency Operations Center in accord with paragraph C-5, Table C-1 and Figure C-1.

Provide assistance to Park Manager or District as required to accomplish the following tasks:

(1) Cancel normal work schedule and provide for key staff as needed.

(2) Access project areas which are or may become unsafe including but not limited to:

(a) Reservoir water surface.

(b) Day use and recreational areas within project boundaries including those managed by others.

(3) Identify areas required for conduct of emergency operations and repairs including any necessary access routes.

(4) Take action to notify and evacuate areas which are unsafe, potentially unsafe, or where emergency operations and repair work may be carried out including, as appropriate.

(a) Directing evacuation of affected project areas managed by the Corps.

(b) Closing project roads to incoming traffic.

(c) Moving equipment to safe areas.

(5) Request assistance as needed in carrying out items (5)(a) and (5)(b) from agencies listed in Table C-2.

(6) Assume District responsibilities for notifications if Emergency condition was declared by Park Manager.

(7) Verify that appropriate warnings are announced over local radio and television.

c. District

(1) Dam Safety Officer

The Dam Safety Officer is to be kept informed of all conditions of the Emergency situation.

Responsible for identifying and/or providing the necessary engineering or technical support required to resolve the emergency situation.

Evaluate the situation and declare an emergency condition if warranted.

Notify the North Central Division Dam Safety Officer in accord with paragraph C-5 if Emergency condition was declared by the Park Manager, Western Flood Control Project Office, or District Office.

Notify the Dam Safety Committee, the Emergency Operations Center and the Project Operations Branch of the situation.

(2) Project Operations Branch

Must be kept informed of all emergency situations.

Responsible for identifying a person-in-charge of the emergency situation. Also, responsible for matters involving normal Dam Operations and/or any other matters not covered by other District elements.

Responsible for contacting the Dam Safety Officer for engineering and technical assistance and keeping him informed of the situation. Also, contact the Emergency Operations Center and keep them informed of the situation.

Evaluate the situation and declare an emergency condition if warranted.

Provide needed assistance and/or instructions to the Western Flood Control Project Office, Park Manager and

person-in-charge of the Emergency situation.

Cancel normal work schedule and provide for key staff as needed.

Determine which of the two planning conditions (PMF without failure or PMF with failure) best represents potential inundation and needs for evacuation.

Determine need for warning of high reservoir levels.

Formulate and issue warning message(s) to affected non-Federal parties in accord with paragraph C-6.

Verify appropriate warnings as released over local radio and television.

(3) Others

The District personnel listed under this category in Table C-1 are only to be contacted if none of the above District Elements could be reached.

Evaluate the Emergency conditions and declare an Emergency condition if warranted. Notify the Dam Safety Officer, the Emergency Operations Center and the Project Operations Branch as soon as possible.

If the Project Operations Branch cannot be contacted, appoint a temporary person-in-charge of the Emergency situation.

Provide needed assistance and/or instructions to Western Flood Control Project Office, Park Manager and person-in-charge of the Pre-Emergency situation.

d. North Central Division

Notify the Office of the Chief of Engineers and other Federal agencies as appropriate.

e. Office of the Chief of Engineers

Notify other Federal agencies as appropriate, such as the Federal Emergency Management Agency.

C-9. Example Messages

Preparation of warning messages should begin as soon as their potential need is apparent so that they can be issued

promptly upon declaration of an emergency condition. Where time is available for their preparation, the initial message should contain all pertinent information. However, in some cases, an emergency condition may be declared with little or no advance notice. The following example messages provide a model for the first announcements in such cases. Subsequent announcements should provide additional details.

a. Announcement for Slowly Developing Conditions

THE ARMY CORPS OF ENGINEERS AT ST. PAUL ANNOUNCED AT (time) TODAY THAT AN EMERGENCY CONDITION EXISTS AT (Name of Dam) DAM DUE TO (general description of problem). THE DAM IS LOCATED ON (stream) ABOUT (distance) MILES UPSTREAM OF (name of downstream community and state).

A CORPS SPOKESMAN SAID THAT THE WATER LEVEL OF (Name of Reservoir) WAS BEING LOWERED (as a precautionary measure/ to reduce pressure on the dam /to enable repair work).

THE SPOKESMAN EMPHASIZED THAT THE DRAWDOWN OF THE LAKE WAS BEING CARRIED OUT UNDER CONTROLLED CONDITIONS AND THERE IS NO IMMEDIATE DANGER OF THE DAM FAILING. HOWEVER, THE LARGE RELEASES OF WATER THAT ARE BEING MADE MAY CAUSE FLOODING ALONG (stream). RESIDENTS OF LOW LYING AREAS ALONG (stream) SHOULD (evacuate/be alert for highwater and prepare to evacuate).

ADDITIONAL INFORMATION WILL BE RELEASED AS PROMPTLY AS POSSIBLE.

b. Announcement for Rapidly Developing Conditions

URGENT: THE ARMY CORPS OF ENGINEERS HAS ANNOUNCED THAT (nameofDam) DAM IS IN IMMINENT DANGER OF FAILURE. THE DAM IS LOCATED ABOUT (distance) MILES UPSTREAM OF (Name of downstream community and state).

ATTEMPTS TO SAVE THE DAM ARE UNDERWAY BUT THEIR SUCCESS CANNOT BE DETERMINED AS YET. RESIDENTS ALONG THE (stream) SHOULD EVACUATE TO HIGH GROUND IMMEDIATELY. RESIDENTS ALONG THE (stream) IN THE VICINITY OF (city) AND DOWNSTREAM SHOULD REMAIN ALERT FOR FURTHER INFORMATION.

IF THE DAM FAILS, WATER WILL TAKE APPROXIMATELY (time) HOURS TO REACH THE LOWER END OF (city, stream,etc.). AREAS CLOSER TO DAM WILL BE

FLOODED SOONER.

ADDITIONAL INFORMATION WILL BE RELEASED AS PROMPTLY AS POSSIBLE.

c. Announcement for High Lake Levels

THE ARMY CORPS OF ENGINEERS AT ST. PAUL ANNOUNCED AT (time) TODAY THAT AN EMERGENCY CONDITION EXISTS AROUND (name of reservoir) DUE TO EXPECTED HIGH WATER LEVELS. THE LAKE IS LOCATED ON (stream) ABOUT (distance) MILES UPSTREAM OF (community and state).

THE CORPS SPOKESMAN SAID THAT THE WATER LEVEL IN THE LAKE WAS EXPECTED TO REACH ELEVATION (elev) AT (time). DUE TO (general description of problem). THIS WATER LEVEL WILL (describe major effects).

LARGE RELEASES OF WATER ARE BEING MADE FROM THE DAM IN AN ATTEMPT TO CONTROL THE LAKE LEVEL. RESIDENTS OF LOW LYING AREAS ALONG (stream) SHOULD BE ALERT TO POSSIBLE FLOODING AND PREPARE TO EVACUATE.

FURTHER INFORMATION WILL BE RELEASED AS PROMPTLY AS POSSIBLE.

# TABLE C-1
# NOTIFICATION LIST
# FOR CORPS OF ENGINEERS
# OFFICES (INTERNAL)

## OBSERVER

1. Observe potential dam problem.
2. Gather pertinent facts to describe situation.
3. Assess whether slowly developing, rapidly developing or imminent failure.
4. Notify first available lockmaster in order shown.

(If contact cannot be made with Lockmasters listed below, contact the Dam Safety Officer, Project Operations Branch, or Emergency Operations Center as shown on the attached list.)

## DAM SUPERVISOR

| | Office | Home Phone | Radio |
|---|---|---|---|
| *Curt Hanson | (612)269-6303 | (612)269-9632 | SSB/FM WUD630 |
| Wayne Gustafson | (612)269-6303 | (612)269-7195 | SSB/FM WUD630 |

1. Assess observer's report.
2. Take necessary emergency actions.
3. Notify Area Lockmaster, Dam Safety Officer, Project Operations Branch, or Emergency Operations Center.

## AREA PROJECT OFFICE

| | Office | Home Phone | Radio |
|---|---|---|---|
| Tim Bertschi | (701)232-1894 | (701)232-5967 | SSB/FM WUD642 |

1. Assess the situation.
2. Take necessary emergency actions.
3. Notify Dam Safety Officer, Project Operations Branch, or Emergency Operations Center.

2 of 4 3 of 4 4 of 4
(REFER TO SHEETS)

# TABLE C-1
# NOTIFICATION LIST
# FOR CORPS OF ENGINEERS
# OFFICES (INTERNAL)

## PROJECT OPERATIONS BRANCH

| | Office | Home Phone |
|---|---|---|
| Dennis Cin | (612)220-0320 | (612)455-6786 |
| Thomas Oksness | (612)220-0322 | (612)439-0272 |
| Dennis Erickson | (612)220-0325 | (612)452-6850 |

Responsible for identifying a person-in-charge of the pre-emergency or emergency situation. Must be kept informed of all pre-emergency or emergency situations. Also contact for matters involving normal dam operations, and/or matters not covered by other District elements. Project Operations Branch will contact Dam Safety Officer for engineering and technical assistance and keep him informed of situation.

OTHER DISTRICT PERSONNEL

| Office | Office | Home Phone | Radio | |
|---|---|---|---|---|
| Western Flood Control Office | | | | |
| Timothy Bertschi | (701)232-1894 | (701)232-5967 | FM | WUD 642 |
| Headwaters Project Office | | | | |
| James Ruyak | (218)566-2306 | (218)566-1294 | FM | WUD 639 |
| Mississippi River Project Office | | | | |
| Richard Otto | (507)895-6341 | (507)895-6224 | FM | WUD 645 |
| Resource Managers | | | | |
| Eau Galle/ Mathiesen | (715)778-5562 | (715)778-4597 | FM/SSB | WUD 643 |
| Homme/ Odegaard | (701)845-2970 | (701)845-2982 | FM/SSB | WUD 636 |
| Baldhill/ Odegaard | (701)845-2970 | (701)845-2982 | FM/SSB | WUD 636 |
| Lk. Traverse/ Salberg | (612)563-4586 | (612)563-4586 | FM/SSB | WUD 638 |
| Orwell/ O'Neel | (218)736-6463 | (612)736-6463 | FM/SSB | WUD 638 |
| Lac Qui Parle/ Hanson | (612)269-6303 | (612)269-9632 | FM/SSB | WUD 630 |
| Sandy/ Daly | (218)426-3482 | (218)426-3482 | FM/SSB | WUD 632 |
| Pokegama/ Kleinert | (218)326-6128 | (218)327-2573 | FM/SSB | WUD 633 |
| Leech Lake/ Zahalka | (218)654-3145 | (218)566-1642 | FM/SSB | WUD 634 |
| Pine River/ Hermerding | (218)692-4488 | (218)692-2118 | FM/SSB | WUD 640 |
| Winnibigoshish/ Dickson | (218)246-8107 | (218)566-2952 | FM/SSB | WUD 631 |
| Gull Lake/ Struss | (218)829-3334 | (218)327-1060 | FM/SSB | WUD 635 |

# TABLE C-1
# NOTIFICATION LIST
# FOR CORPS OF ENGINEERS
# OFFICES (INTERNAL)

## DAM SAFETY OFFICER*

| | Office | Home Phone |
|---|---|---|
| Robert Post | (612)220-0303 | (612)437-1316 |
| William Goetz | (612)220-0310 | (612)454-3722 |
| Stan Kumpula | (612)220-0304 | (612)484-8957 |

To be informed of all pre-emergency or emergency situations. responsible for identifying and/or providing the necessary engineering or technical support required to resolve the pre-emergency or emergency situation.

## DAM SAFETY COMMITTEE

| | Office | Home Phone |
|---|---|---|
| William Goetz | (612)220-0310 | (612)454-3722 |
| Helmer Johnson | (612)220-0602 | (612)633-7791 |
| Robert Engelstad | (612)220-0610 | (612)459-6343 |
| Robert Fletcher | (612)220-0510 | (612)484-4998 |
| Dennis Cin | (612)220-0320 | (612)455-6786 |
| Dale Mazar | (612)220-0444 | (612)631-1940 |
| Stan Kumpula | (612)220-0304 | (612)484-8957 |

## NCD DAM SAFETY OFFICER*

| | Office | Home Phone |
|---|---|---|
| Zane Goodwin* | (312)353-6311 | (312)823-4606 |
| Carl Cable | (312)353-6372 | (312)357-4529 |
| Don Leonard | (312)353-6355 | (312)359-3372 |
| Lee Hoglind | (312)353-6358 | (312)579-0148 |

## OCE DAM SAFETY OFFICER*

| | Office | Home Phone |
|---|---|---|
| Lloyd Duscha* | (202)272-0382 | (703)860-1319 |
| William McCormick | (202)272-0397 | (703)569-4323 |
| John McPherson | (202)272-0215 | (703)659-2650 |
| Edward Prickett | (202)272-0207 | (301)865-5876 |
| Robert Smith | (202)272-0220 | (703)569-3128 |
| Earl Elker | (202)272-8500 | (301)465-2120 |
| John Elmore | (202)272-0196 | (703)339-8279 |

# TABLE C-1
# NOTIFICATION LIST FOR CORPS OF ENGINEERS OFFICES (INTERNAL)

## EMERGENCY OPERATIONS CENTER

| | Office | Home Phone |
|---|---|---|
| District EOC | (612)220-0208 | (24-hr. Number) |
| David Christenson | (612)220-0204 | (612)690-5749 |

Twenty-four (24) hour telephone service. Must be kept informed of all pre-emergency or emergency situations. Also contact for matters involving national security, disasters, mobilization or NWR flood forecasts. Center will contact Dam Safety Officer, the Commander/District Engineer and NCD.

## DISTRICT ENGINEER

| | Office | Home Phone |
|---|---|---|
| Col. Roger L. Baldwin | (612)220-0300 | (612)894-6410 |

## PUBLIC AFFAIRS OFFICE

| | Office | Home Phone |
|---|---|---|
| Kennon Gardner | (612)220-0201 | (612)884-9023 |
| 24-Hr. Answer Machine | (612)220-0200 | |

## NCD, EMERGENCY MANAGER

| | Office | Home Phone |
|---|---|---|
| Natural Disaster Planner Bernard Bochantin | (312)353-5275 | (815)568-7544 |
| Chief Emergency Management Tim Monteen | (312)886-8451 | (312)961-2195 |

## DISTRICT RADIO

| | | |
|---|---|---|
| Contact Electronic Service Center at | (612)437-2210 | WUD6 |
| SSB Primary | | 5400Khz |
| 1st Alternate | | 6020Khz |
| Emergency | | 5015KhzLSB |

For additional information see Appendix CNCS 500-1-1.

TABLE C-2

KEY CONTACTS FOR EMERGENCY NOTIFICATIONS - EXTERNAL

| CITIES AND TOWNS | Telephone Office | Residence |
|---|---|---|
| Montevideo, MN. | | |
| Sheriff | (612) 269-8808 | (24 hours) |
| Wagdahl, MN. | | |
| County Sheriff | (612) 564-2130 | (24 hours) |
| Granite Falls | | |
| Police | (612) 564-2129 | (24 hours) |
| Emergency Coordinator | (612) 564-2423 | (612) 564-4622 |
| **COUNTIES** | | |
| La qui Parle | | |
| Sheriff | (612) 598-3720 | (24 hours) |
| Civil Defense Director | (612) 269-8563 | (612) 269-9102 |
| Chippewa | | |
| Sheriff | (612) 269-9363 | (24 hours) |
| Civil Defense Director | (612) 269-8583 | (612) 269-9102 |
| Yellow Medicine | | |
| Sheriff | (612) 564-2130 | (24 hours) |
| Civil Defense Director | (612) 269-8583 | (612) 269-9102 |
| **STATE AGENCIES** | | |
| MN. Division of Emergency Services | (612) 296-2233 | (612) 778-0800 |
| Region V Coordinator | (507) 389-1921 | (507) 345-4873 |
| MN. Dept. of Natural Resources | (612) 296-2922 | |
| N.D. Disaster Emergency Services | (701) 224-2111 | (701) 224-2121 |
| **FEDERAL AGENCIES** | | |
| National Weather Service | (612) 725-3401 | |
| **EXTERNAL** | | |
| State of Minnesota | | |
| Statewide Emergency Number | 1-800-422-0798 | |
| Metro Area | (612) 649-5451 | |
| Backup Only | (612) 296-2100 | |

TABLE C-3

IDENTIFICATION OF EMERGENCY CONDITIONS AND REQUIRED INTERNAL AND EXTERNAL NOTIFICATIONS

| ELEVATION* | PROBLEM | PARTIES TO BE NOTIFIED | ACTION |
|---|---|---|---|
| 1. HIGH RESERVOIR LEVEL | | | |
| 937.6 | Normal Pool<br>Marsh Lake Dam | Western Flood Control<br>Project Office (WFCPO)<br>District | |
| 933.9 | Normal Pool<br>Lac qui Parle | | |
| 941.14 | Full Pool at<br>Marsh Lk. Dam and<br>Lac qui Parle | WFCPO<br>District<br>North Central Division (NCD)<br>National Weather Service (NWS) | Apprise them of situation (for information only). |
| 945.0 | Major Upstream Stage<br>(Real Estate Taking Line<br>is Elev. 983.0 for Marsh<br>Lk. Dam and Lac qui Parle | WFCPO<br>District<br>NCD<br>NWS<br>MN-Disaster Emerg. Services (MN-DES)<br>County Civil Defense<br>Coordinators (CCDC) | Apprise them of situation (for information only). |
| 2. EMERGENCY DRAWDOWN | | | |
| | Possible Failure of<br>Lac qui Parle Dam<br>(Failure not imminent) | WFCPO<br>District<br>NCD<br>NWS<br>MN-DES<br>CCDC's | Apprise them of the situation and that we are increasing discharges. |

*Elevation refers to NGVD.

TABLE C-3 (Continued)

IDENTIFICATION OF EMERGENCY CONDITIONS AND REQUIRED INTERNAL AND EXTERNAL NOTIFICATIONS (Cont'd)

| ELEVATION* | PROBLEM | PARTIES TO BE NOTIFIED | ACTION |
|---|---|---|---|
| 3. IMMINENT DAM FAILURE | | | |
| 946.0 | Overtopping of Lac qui Parle Dam | WFCPO<br>District<br>NCD<br>MN-DES<br>CCDC's<br>NWS | Apprise them of the situation. Use caution/ evacuate. (As appropriate). |
| - | Failure of the embankment | WFCPO<br>District<br>NCD<br>MN-DES<br>CCDC's<br>NWS | Apprise them of the situation. Use extreme caution/evacuate. (As appropriate). Begin immediate drawndown. |

*Elevation refers to NGVD.

# EMERGENCY PLAN

# FOR

# LAC QUI PARLE FLOOD CONTROL PROJECT

## APPENDIX D

## INUNDATION MAPS
## LAC QUI PARLE DAM

Prepared By
ST. PAUL DISTRICT
U.S. ARMY CORPS OF ENGINEERS

OCTOBER 1988

## TABLE OF CONTENTS



## LIST OF PLATES

FLOOD EMERGENCY PLAN

FOR

LAC QUI PARLE DAM AND RESERVOIR

D-1. Introduction

This appendix presents the Inundation Maps and other hydraulic data for the area downstream of the Lac qui Parle Dam for the cases of Probable Maximum Flood with and without dam failure and failure at Normal High Pool Level.

D-2. Explanation of Plates

The attached maps (Plates D-1 thru D-6) indicate the area which would be flooded under the hypothesized conditions of: a) occurrence of a probable maximum flood (PMF) at Lac qui Parle Dam; and b) occurrence of a failure of the dam concurrent with a probable maximum flood. The elapsed times for selected conditions at downstream locations are listed on Plate D-1. The possibility is extremely remote that either condition will occur. Pertinent hydraulic data assiciated with the reservoir and area downstream of Lac qui Parle Dam are shown on Plates D-7 through D-14 inclusive.

Preparation of the maps does not reflect on the safety or integrity of Lac qui Parle Dam. They have been prepared as part of a national program to prepare similar maps for all Federal Dams.

D-3. Use of Maps

The attached maps provide a basis for evaluation existing evacuation plans for the affected area and development of any further plans which are needed. The Corps of Engineers recommends that such evaluations be made and any needed supplemental plans be developed. Information on evacuation planning and examples of evacuation plans are available from the Corps of Engineers.

The general procedure for use of the attached maps is as follows:

a. Determine the portion of your area of concern which would be affected by inundation or isolation.

b. Identify routes which would be used for movement of people from each part of the area to be evacuated.

c. Identify the amount of time available for evacuation.

d. Use the ingormation to assess whether existing evacuation plans cover all of the affected area and will provide for timely evacuation.

D-4. Definition of Terms

| | |
|---|---|
| River Mile | The distance along the channel of the Minnesota River measured along the channel downstream from the dam. |
| Peak elevation | The computed maximum water surface elevation which would be reached at a location due to assumed conditions. |
| Peak time | Elapsed time* after assumed event until peak discharge occurs. |
| NGVD | National Geodetic Vertical Datum (distance above 1929 mean sea level). |
| Probable Maximum Flood | The theoretical maximum flow that can be expected from the watershed. |
| Dam failure | Any condition resulting in the uncontrolled release of water other that over or through an uncontrolled spillway or outlet works. |
| Cross Section | Point at which the shape of a stream channel or valley is measured, usually in a direciton perpendicualr to the direction of flow. |

*Elapsed time for the case of Probable Maximum Flood without failure is measured from the time at which the reservoir level exceeds the top of the flood control pool. Elapsed time for the case of Probable Maximum Flood with failure is measured from the beginning of the actual dam failure.

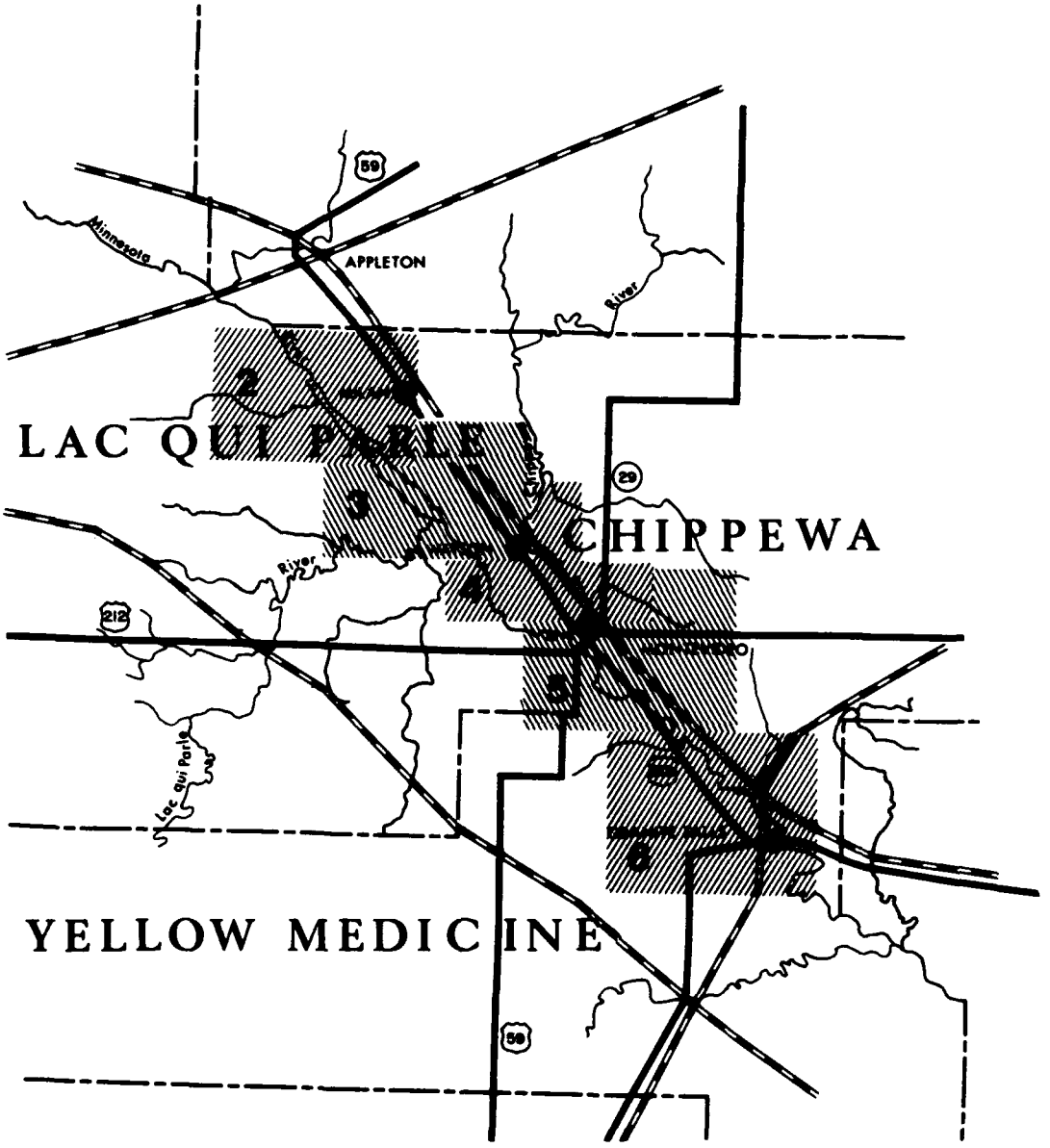
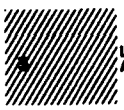

APPLETON
LAC QUI PARLE
CHIPPEWA
YELLOW MEDICINE
Minnesota
River
Lac qui Parle
59
212
29
56
2
3
5
6

TABLE B-1

| X-SECT NUMBER | RIVER MILE | DISTANCE FROM DAM (MILES) | PROBABLE MAXIMUM FLOOD "WITHOUT DAM FAILURE" PEAK FLOOD TIME (HRS-MIN) | PROBABLE MAXIMUM FLOOD "WITHOUT DAM FAILURE" PEAK ELEVATION (FT ABOVE MSL) | PROBABLE MAXIMUM FLOOD "WITH DAM FAILURE" PEAK FLOOD TIME (HRS-MIN) | PROBABLE MAXIMUM FLOOD "WITH DAM FAILURE" PEAK ELEVATION (FT ABOVE MSL) |
|---|---|---|---|---|---|---|
| 4 | 285.2 | 2.8 | 37-00 | 945.2 | 4-00 | 945.1 |
| 9 | 278.9 | 9.2 | 38-00 | 944.1 | 5-00 | 944.2 |
| 11 | 277.9 | 10.2 | 38-30 | 944.1 | 5-30 | 944.2 |
| 12 | 276.7 | 11.4 | 40-00 | 944.1 | 6-00 | 944.1 |
| 14 | 273.3 | 14.8 | 42-00 | 938.3 | 8-00 | 941.2 |
| 15 | 271.3 | 16.8 | 44-00 | 935.8 | 9-00 | 936.8 |
| 17 | 268.1 | 20.0 | 47-00 | 925.8 | 10-30 | 927.5 |
| 18 | 266.4 | 21.7 | 48-00 | 917.3 | 11-15 | 919.3 |
| 19 | 265.9 | 22.2 | 48-00 | 913.5 | 11-15 | 915.1 |
| 20 | 265.6 | 22.5 | 48-00 | 904.6 | 11-15 | 906.1 |
| 23 | 263.8 | 24.5 | 48-00 | 898.0 | 12-00 | 901.6 |

(2)


## LEGEND




LOCATION OF MAP PANELS AND PLATE NUMBERS

RAILWAYS

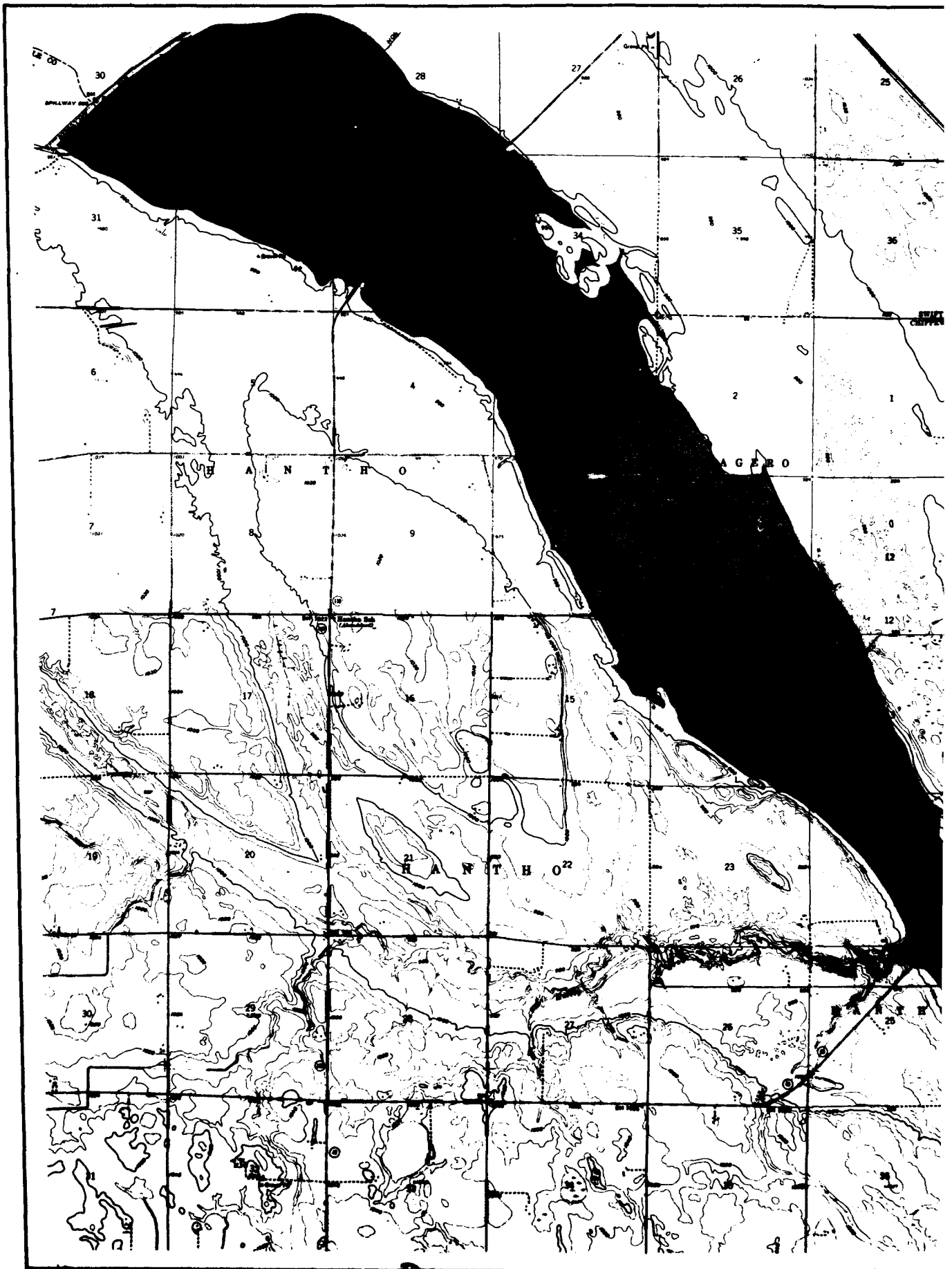

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

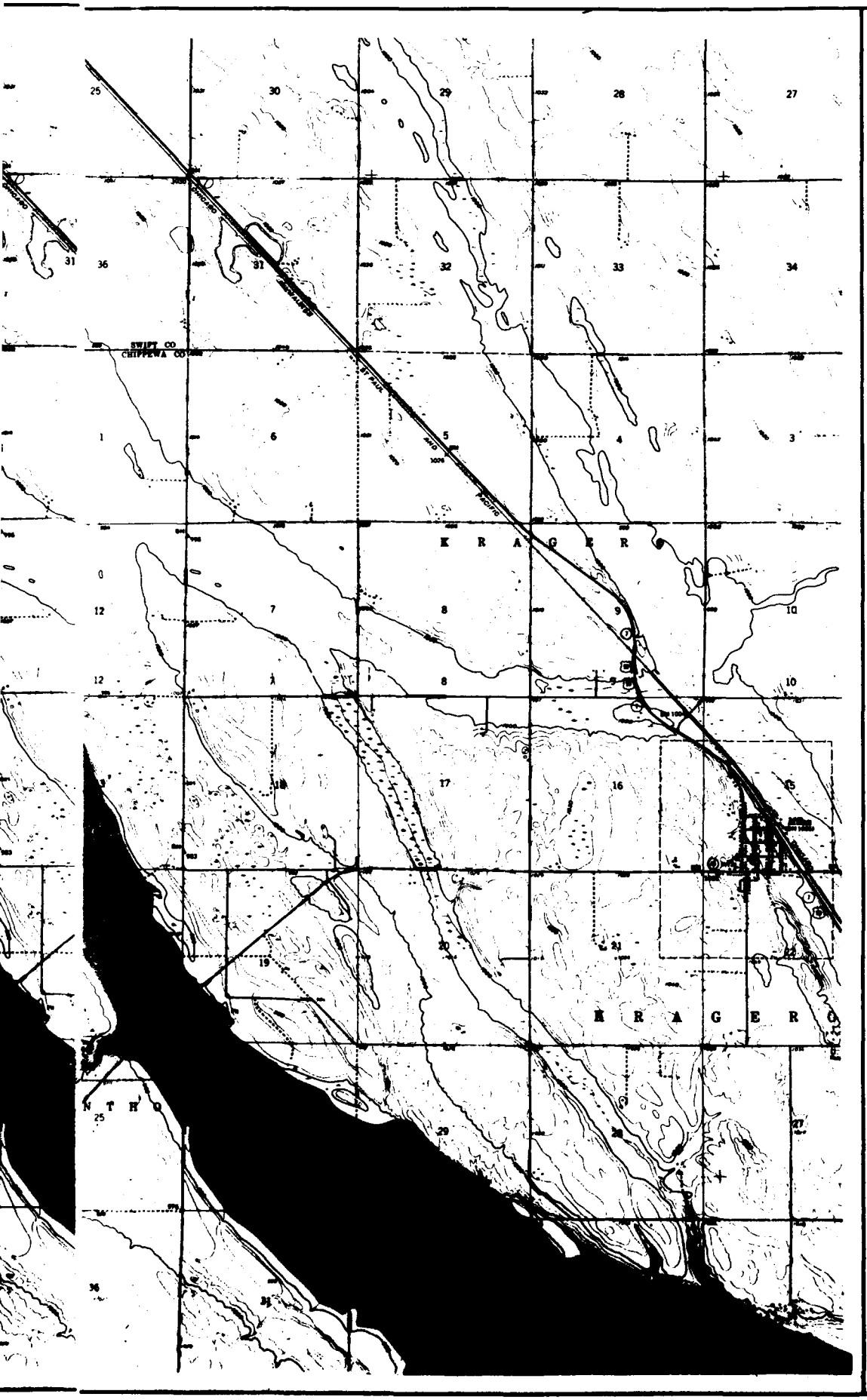
# LAC QUI PARLE DAM, MINNESOTA
# EMERGENCY PLAN
## INUNDATION MAPS

OCTOBER 1983

★ U.S. GOVERNMENT PRINTING OFFICE: 1984 756-943

PLATE D-1


H A I N T H O
A G E R O
H A N T H O




N

## LEGEND

LIMIT OF PROBABLE MAXIMUM FLOOD WITHOUT DAM FAILURE

LIMIT OF PROBABLE MAXIMUM FLOOD WITH DAM FAILURE

CROSS SECTION 9

1000 0 1000 2000 3000 4000

SCALE IN FEET

CONTOUR INTERVAL 10 FEET.
NATIONAL GEODETIC VERTICAL DATUM OF 1929.
SOURCE OF BASE MAP: U.S. GEOLOGICAL SURVEY 7.5 MINUTE SERIES.

NOTE: THE INUNDATED AREAS SHOWN ON THIS MAP REFLECT EVENTS OF AN EXTREMELY REMOTE NATURE. THESE RESULTS ARE NOT IN ANY WAY INTENDED TO REFLECT UPON THE INTEGRITY OF THE LAC QUI PARLE DAM.

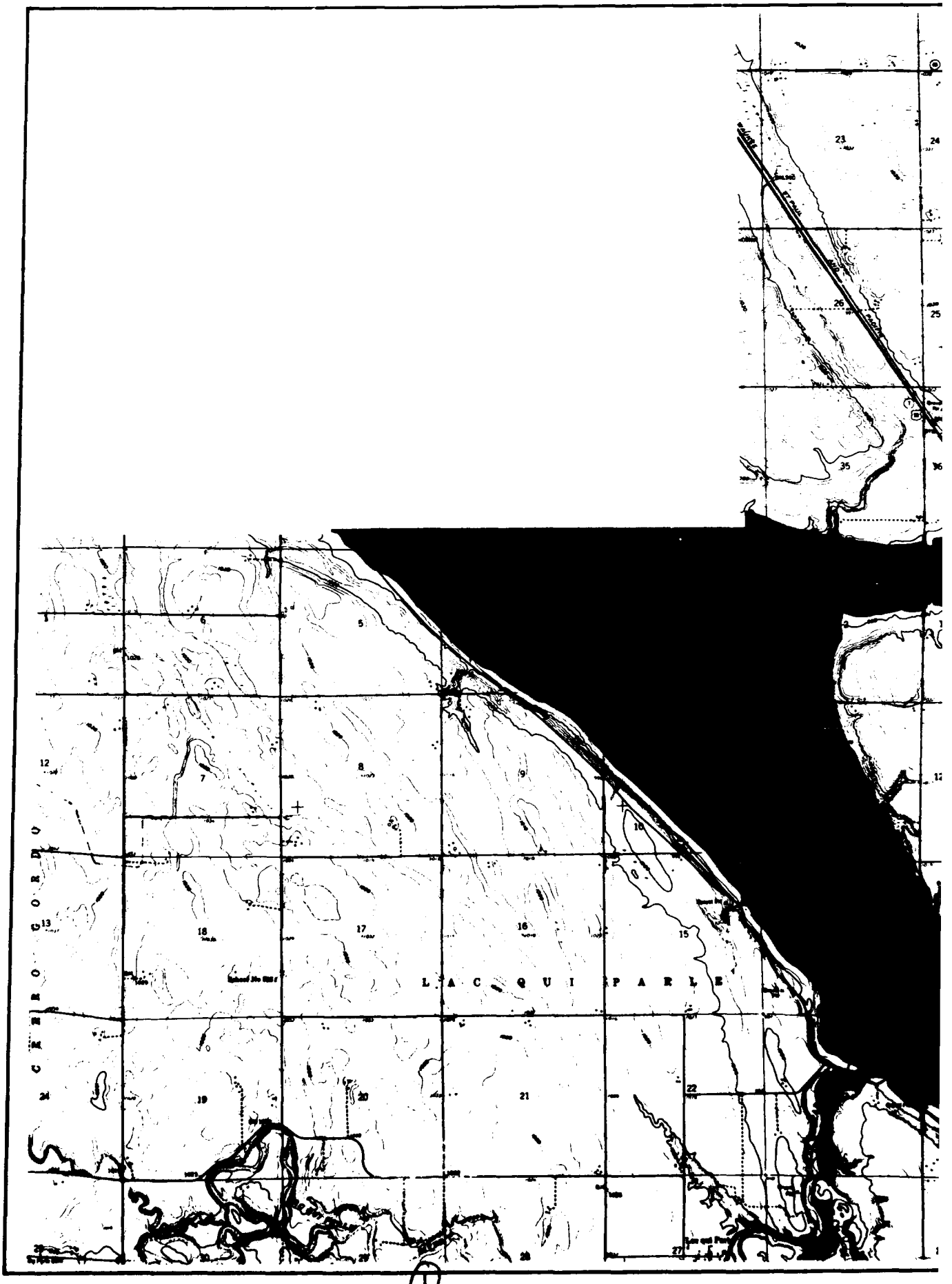
U.S. ARMY ENGINEER DISTRICT, ST. PAUL
CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

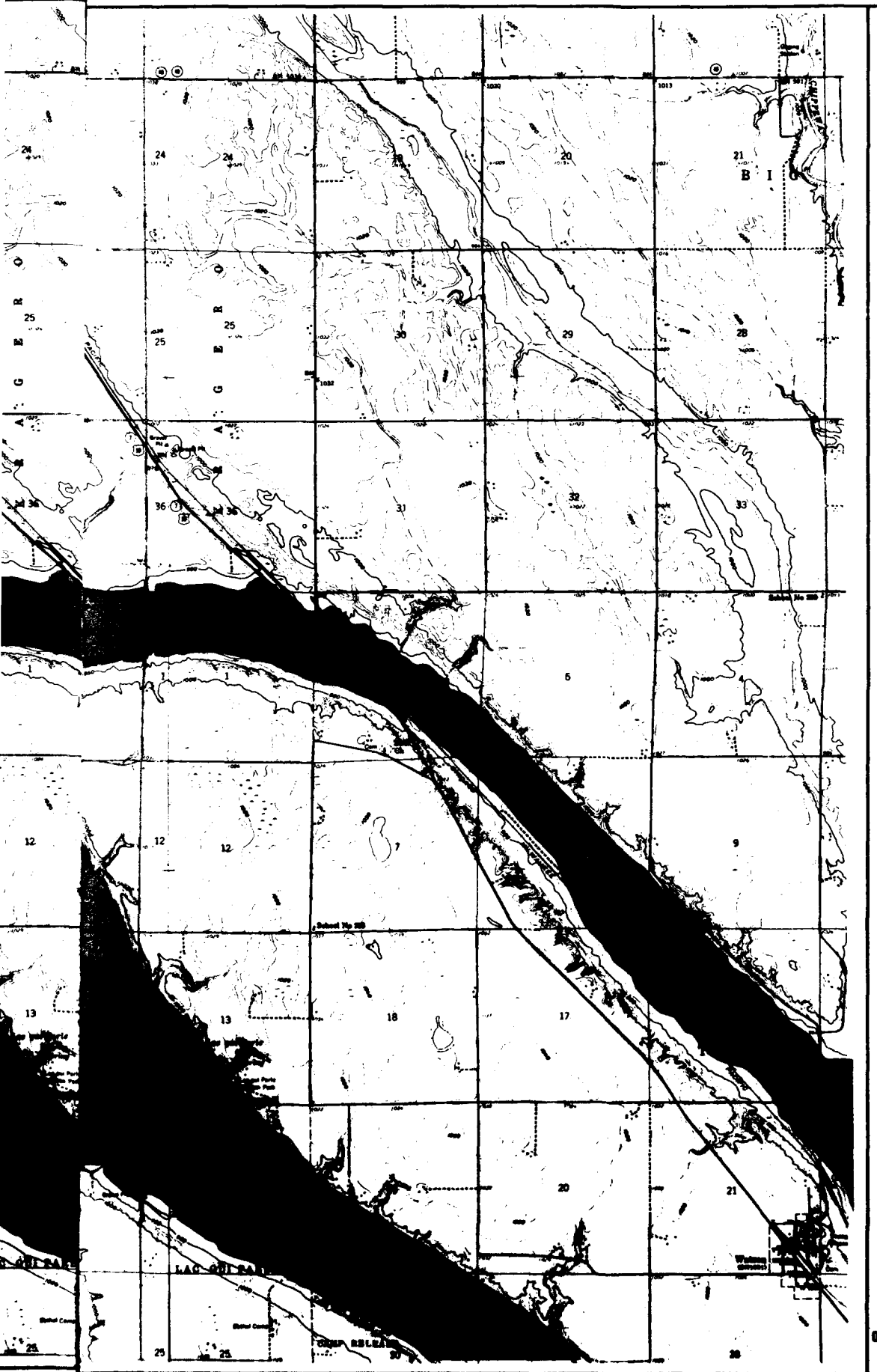
# LAC QUI PARLE DAM, MINNESOTA EMERGENCY PLAN INUNDATION MAP

OCTOBER 1983 (2)

★ U.S. GOVERNMENT PRINTING OFFICE: 1984 756-943

PLATE B-2


CHIPPEWA
LAC QUI PARLE




N

## LEGEND

LIMIT OF PROBABLE MAXIMUM FLOOD WITHOUT DAM FAILURE

LIMIT OF PROBABLE MAXIMUM FLOOD WITH DAM FAILURE

CROSS SECTION (9)

1000 0 1000 3000 5000 7000

SCALE IN FEET

CONTOUR INTERVAL 10 FEET.
NATIONAL GEODETIC VERTICAL DATUM OF 1929.
SOURCE OF BASE MAP: U.S. GEOLOGICAL SURVEY 7.5 MINUTE SERIES.

NOTE: THE INUNDATED AREAS SHOWN ON THIS MAP REFLECT EVENTS OF AN EXTREMELY REMOTE NATURE. THESE RESULTS ARE NOT IN ANY WAY INTENDED TO REFLECT UPON THE INTEGRITY OF THE LAC QUI PARLE DAM.

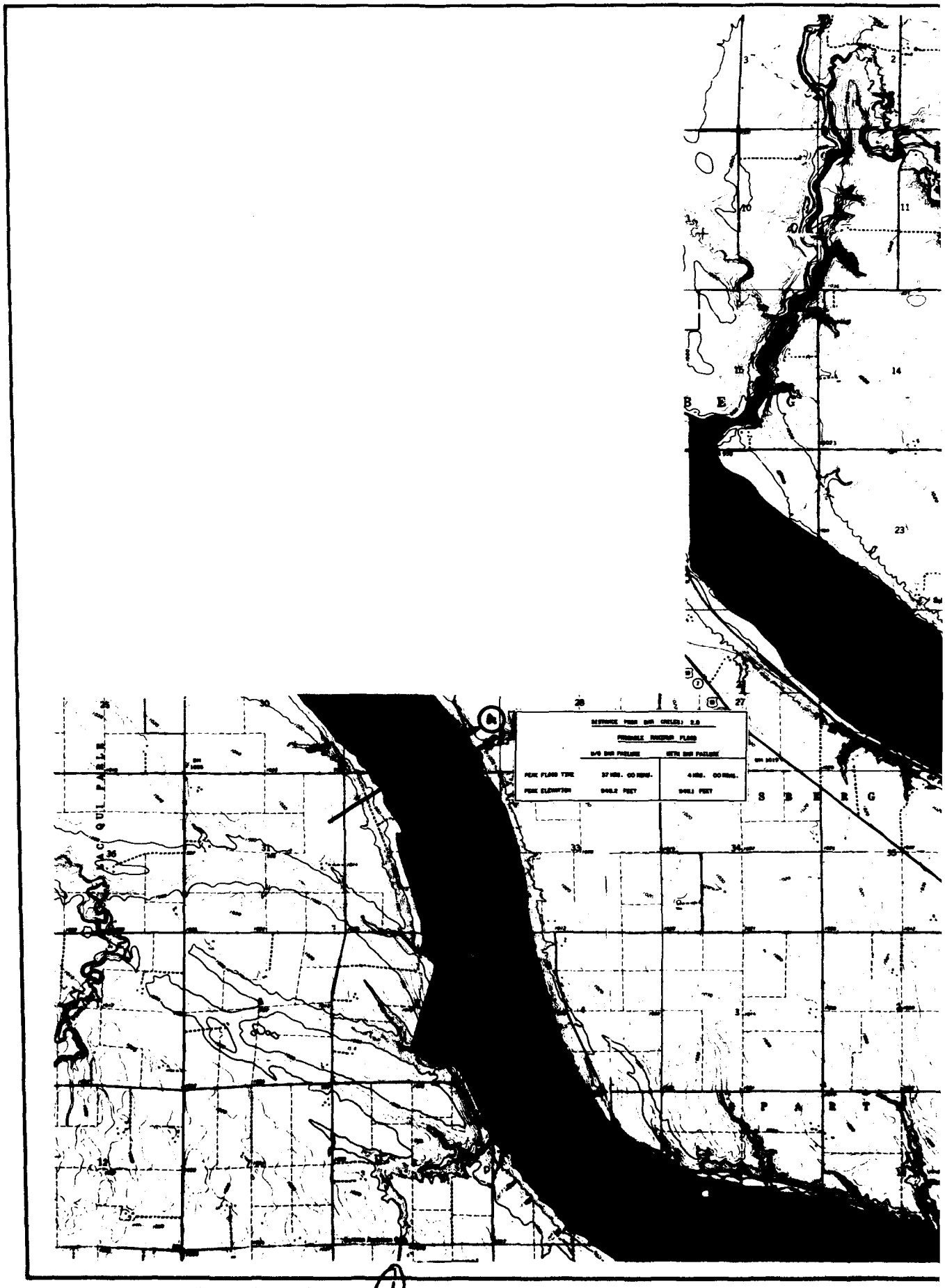
U.S. ARMY ENGINEER DISTRICT, ST. PAUL
CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

# LAC QUI PARLE DAM, MINNESOTA EMERGENCY PLAN INUNDATION MAP

OCTOBER 1983 (2)

★ U.S. GOVERNMENT PRINTING OFFICE: 1984 756-943

PLATE D-3




★ U.S. GOVERNMENT PRINTING OFFICE: 1984 756-943


N

## LEGEND

LIMIT OF PROBABLE MAXIMUM FLOOD WITHOUT DAM FAILURE

LIMIT OF PROBABLE MAXIMUM FLOOD WITH DAM FAILURE

CROSS SECTION 9

1000 0 1000 3000 5000 7000

SCALE IN FEET

CONTOUR INTERVAL 10 FEET.
NATIONAL GEODETIC VERTICAL DATUM OF 1929.
SOURCE OF BASE MAP: U.S. GEOLOGICAL SURVEY 7.5 MINUTE SERIES.

NOTE: THE INUNDATED AREAS SHOWN ON THIS MAP REFLECT EVENTS OF AN EXTREMELY REMOTE NATURE. THESE RESULTS ARE NOT IN ANY WAY INTENDED TO REFLECT UPON THE INTEGRITY OF THE LAC QUI PARLE DAM.

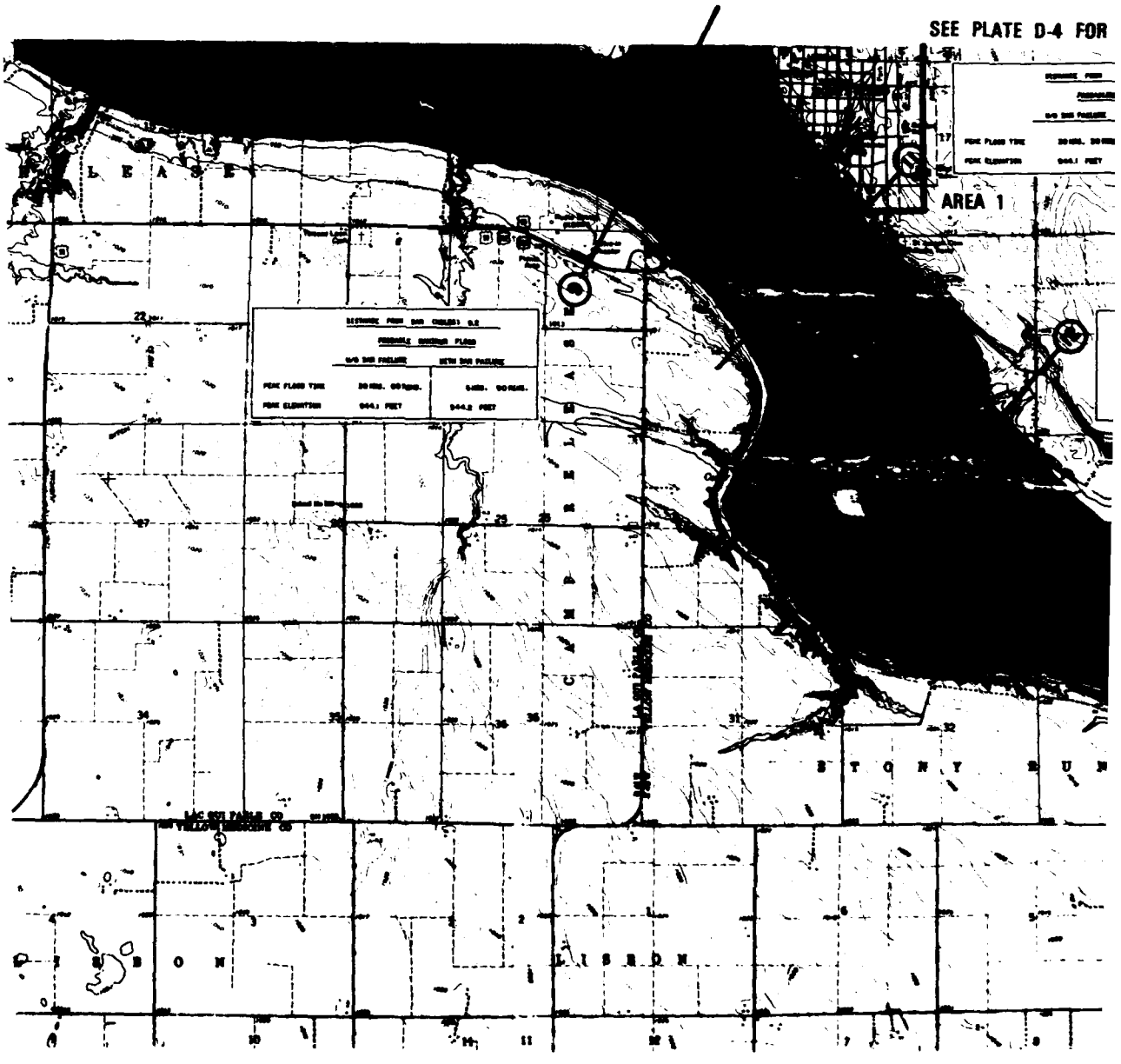
U.S. ARMY ENGINEER DISTRICT, ST. PAUL
CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

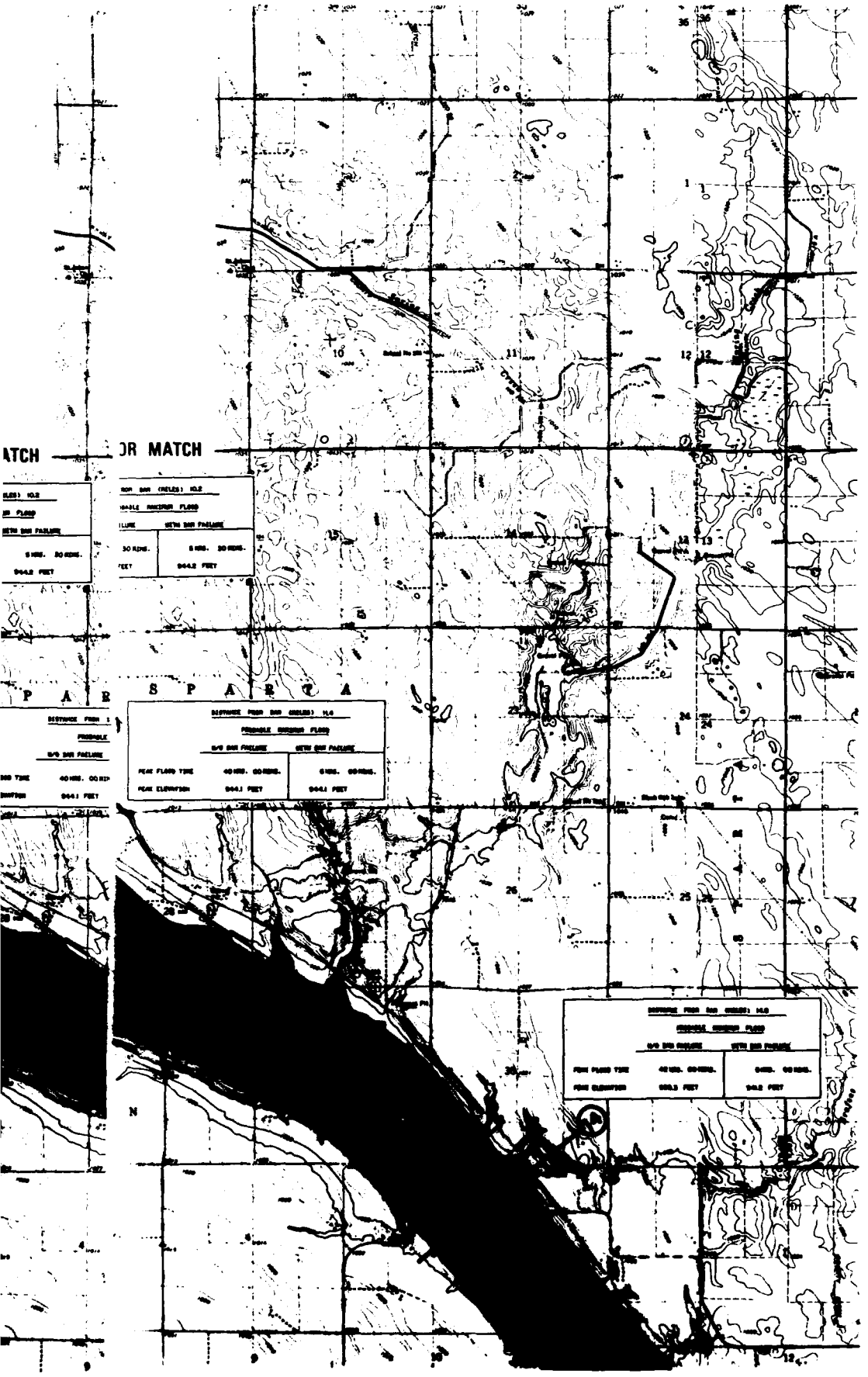
# LAC QUI PARLE DAM, MINNESOTA EMERGENCY PLAN INUNDATION MAP

(2)

OCTOBER 1983

SEE PLATE D-5 FOR MATCH


SEE PLATE D-4 FOR
AREA 1
L E A S E
B O N




N

## LEGEND

LIMIT OF PROBABLE MAXIMUM FLOOD WITHOUT DAM FAILURE

LIMIT OF PROBABLE MAXIMUM FLOOD WITH DAM FAILURE

CROSS SECTION 9

1000 0 1000 3000 5000 7000

SCALE IN FEET

CONTOUR INTERVAL 10 FEET.
NATIONAL GEODETIC VERTICAL DATUM OF 1929.
SOURCE OF BASE MAP: U.S. GEOLOGICAL SURVEY 7.5 MINUTE SERIES.

NOTE: THE INUNDATED AREAS SHOWN ON THIS MAP REFLECT EVENTS OF AN EXTREMELY REMOTE NATURE. THESE RESULTS ARE NOT IN ANY WAY INTENDED TO REFLECT UPON THE INTEGRITY OF THE LAC QUI PARLE DAM.

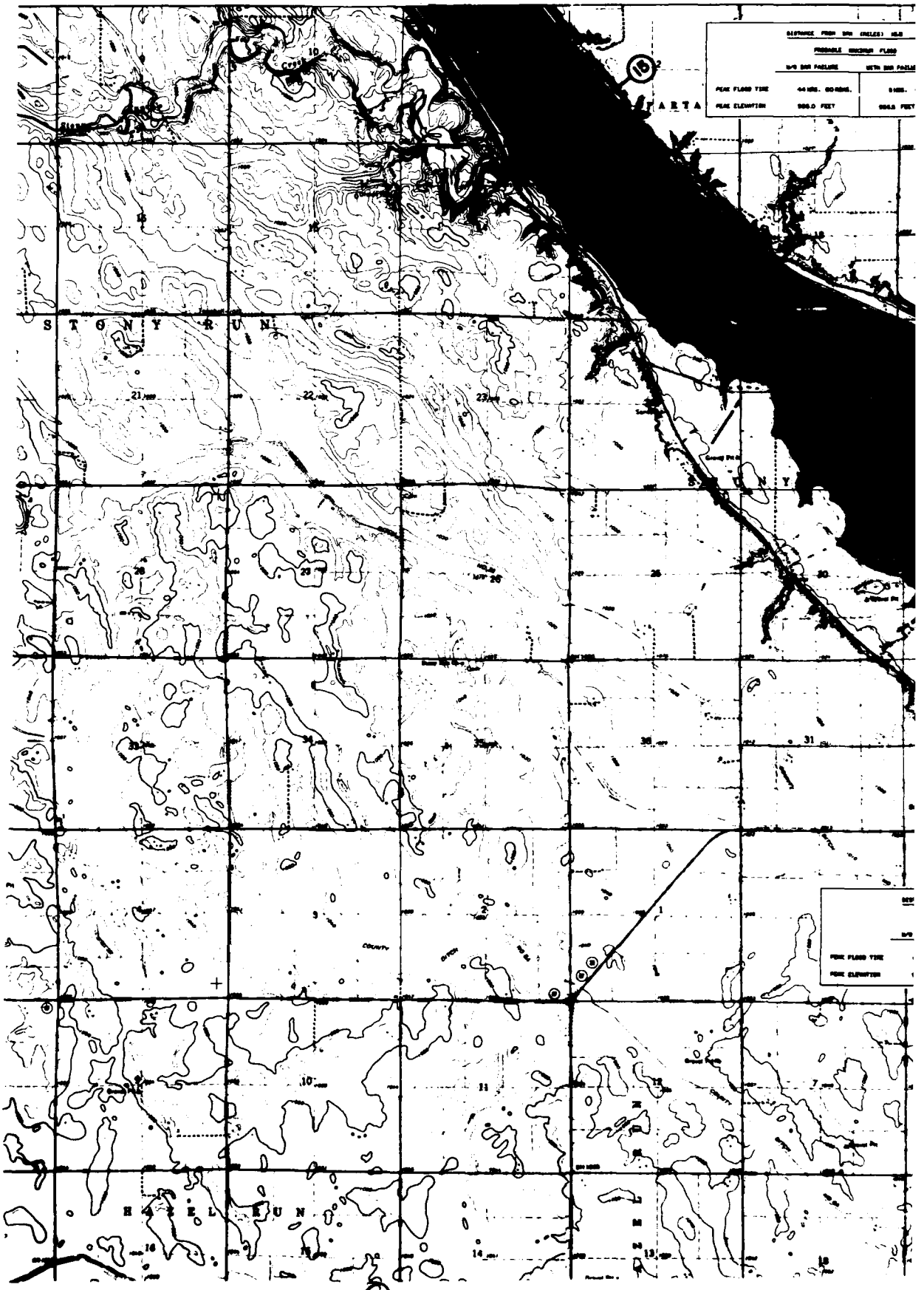
U.S. ARMY ENGINEER DISTRICT, ST. PAUL
CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

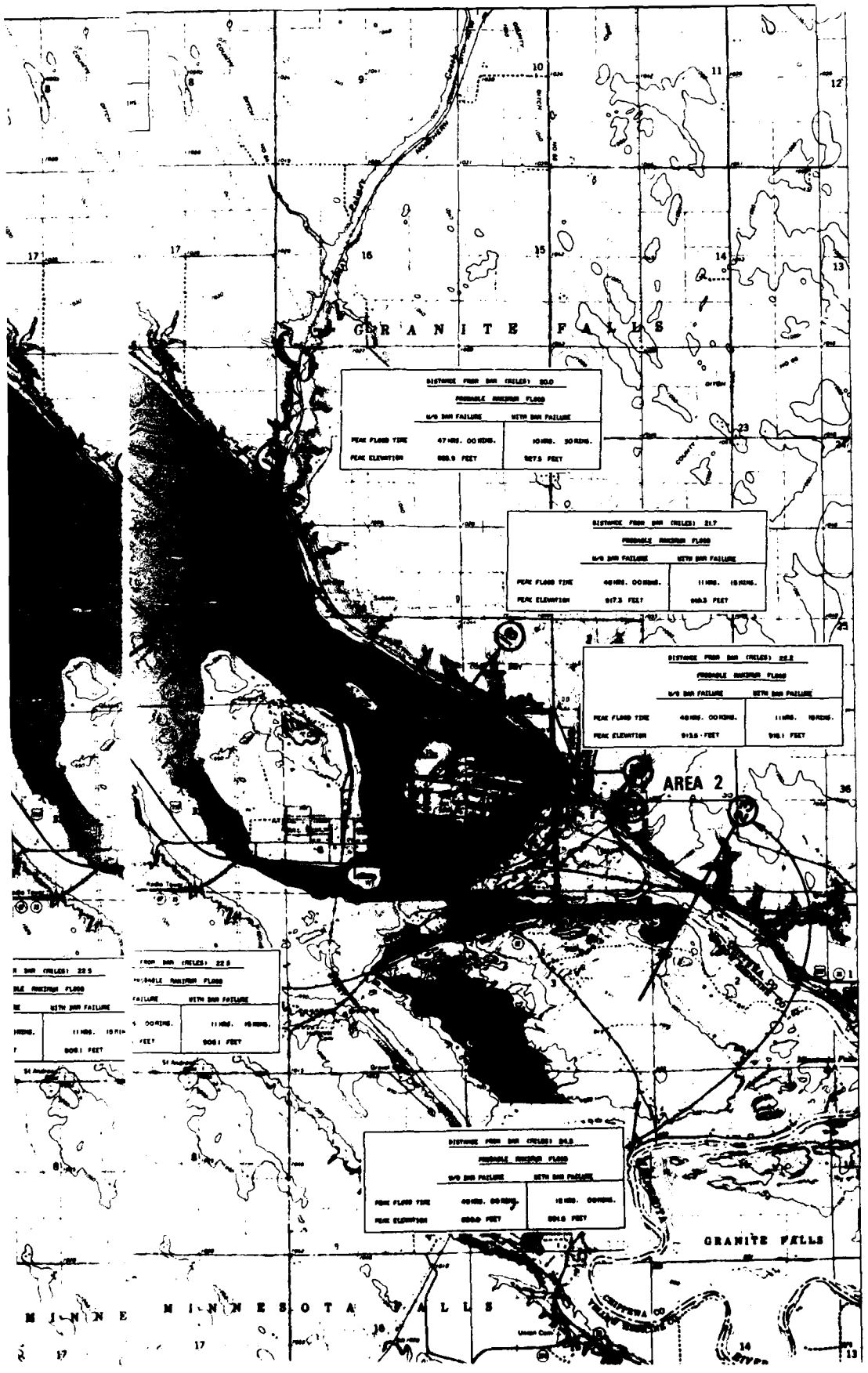
# LAC QUI PARLE DAM, MINNESOTA EMERGENCY PLAN INUNDATION MAP

(2)

OCTOBER 1983

★ U.S. GOVERNMENT PRINTING OFFICE: 1984 756-943


STONY RUN
HAZEL RUN




N

## LEGEND

LIMIT OF PROBABLE MAXIMUM FLOOD WITHOUT DAM FAILURE

LIMIT OF PROBABLE MAXIMUM FLOOD WITH DAM FAILURE

CROSS SECTION (9)

1000 0 1000 3000 5000 7000

SCALE IN FEET

CONTOUR INTERVAL 10 FEET.
NATIONAL GEODETIC VERTICAL DATUM OF 1929.
SOURCE OF BASE MAP: U.S. GEOLOGICAL SURVEY 7.5 MINUTE SERIES.

NOTE: THE INUNDATED AREAS SHOWN ON THIS MAP REFLECT EVENTS OF AN EXTREMELY REMOTE NATURE. THESE RESULTS ARE NOT IN ANY WAY INTENDED TO REFLECT UPON THE INTEGRITY OF THE LAC QUI PARLE DAM.

**U.S. ARMY ENGINEER DISTRICT, ST. PAUL**
**CORPS OF ENGINEERS**
**ST. PAUL, MINNESOTA**

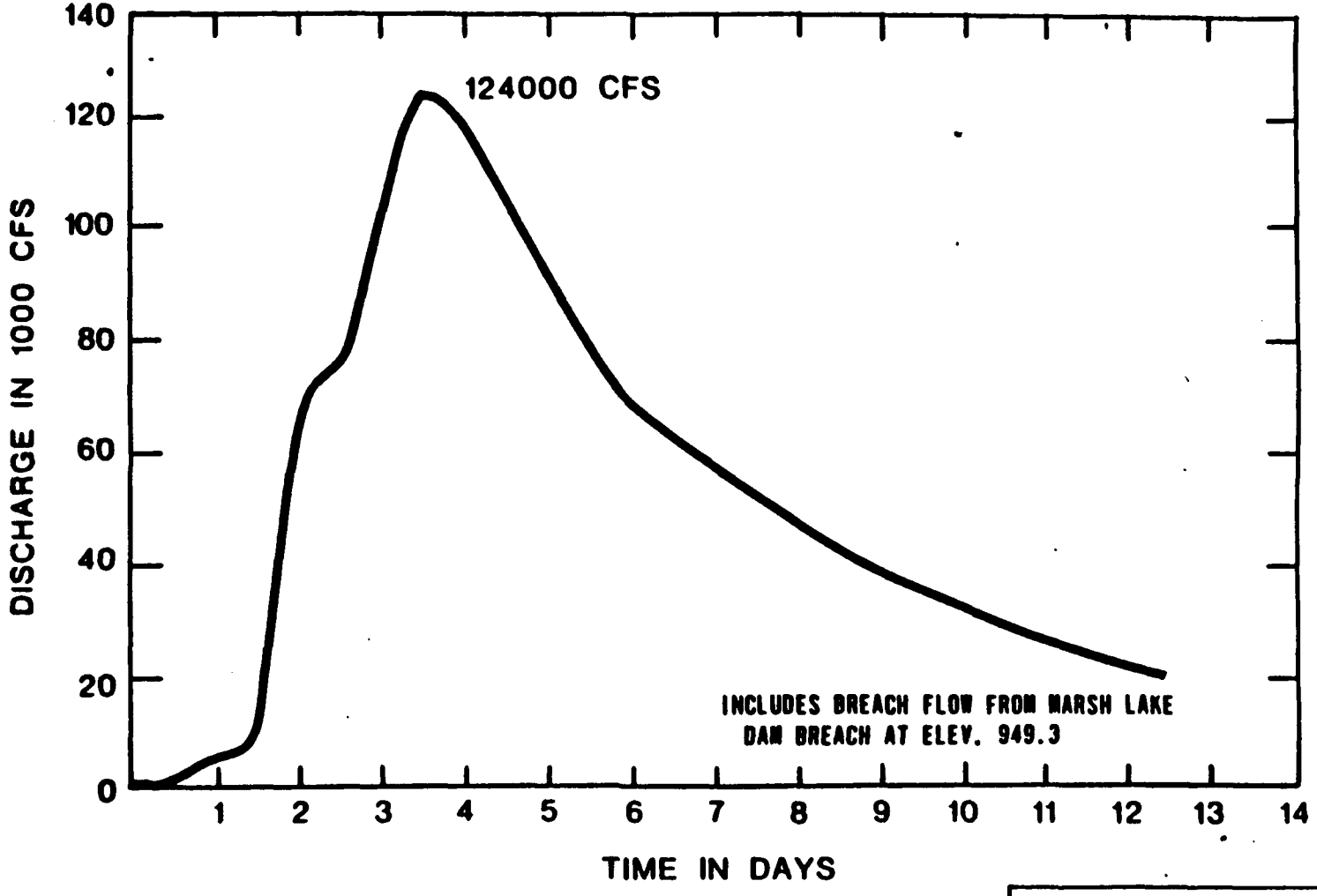
# LAC QUI PARLE DAM, MINNESOTA
# EMERGENCY PLAN
# INUNDATION MAP

(2)

OCTOBER 1983

★ U.S. GOVERNMENT PRINTING OFFICE: 1984 756-943

# PROBABLE MAXIMUM FLOOD INFLOW HYDROGRAPH




EMERGENCY PLAN
LAC QUI PARLE
DAM
ST. PAUL DISTRICT
U.S. ARMY CORPS OF ENGINEERS

PLATE D-7

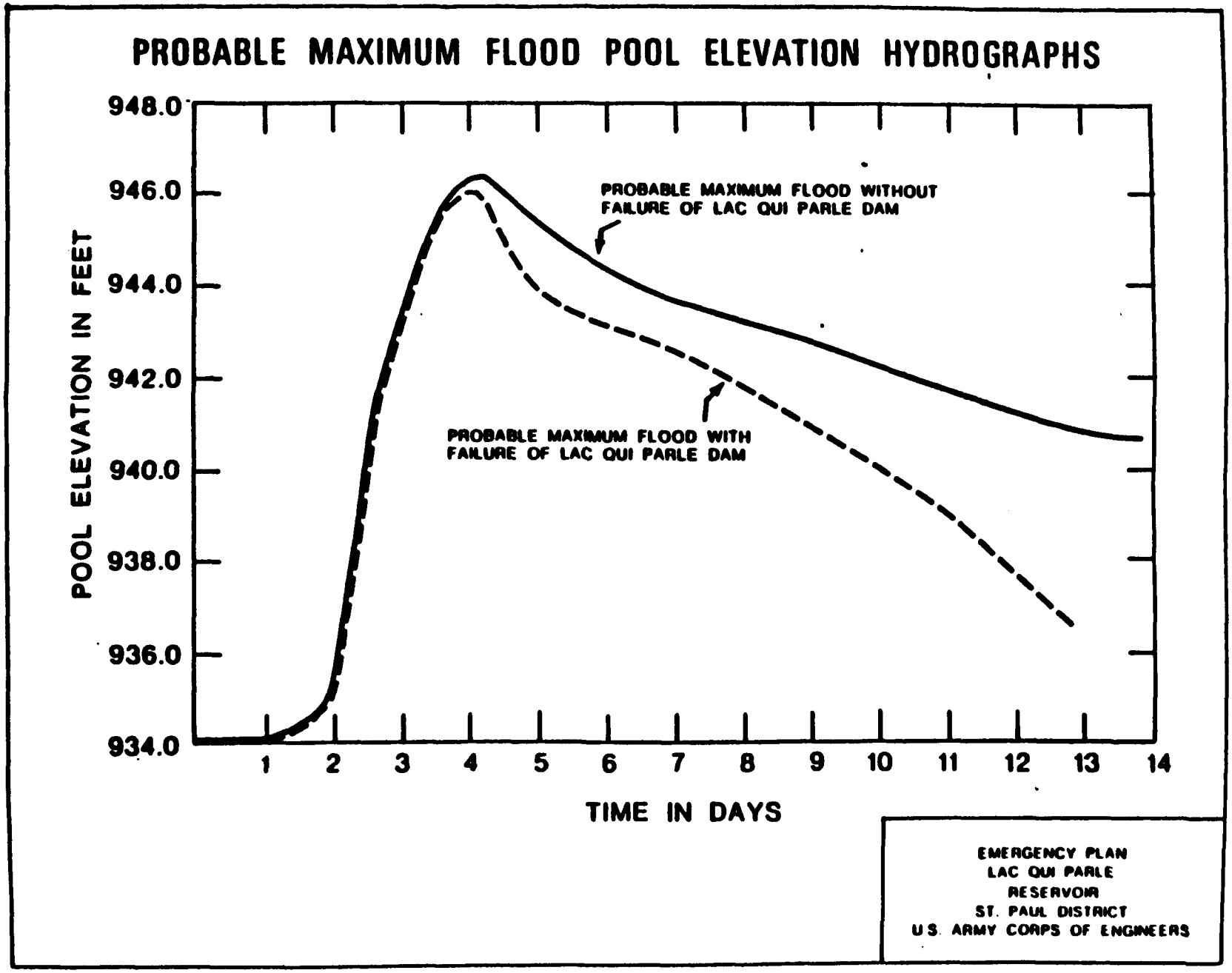

PROBABLE MAXIMUM FLOOD POOL ELEVATION HYDROGRAPHS
948.0
946.0
944.0
942.0
940.0
938.0
936.0
934.0
POOL ELEVATION IN FEET
PROBABLE MAXIMUM FLOOD WITHOUT FAILURE OF LAC QUI PARLE DAM
PROBABLE MAXIMUM FLOOD WITH FAILURE OF LAC QUI PARLE DAM
1
2
3
4
5
6
7
8
9
10
11
12
13
14
TIME IN DAYS
EMERGENCY PLAN
LAC QUI PARLE
RESERVOIR
ST. PAUL DISTRICT
U.S. ARMY CORPS OF ENGINEERS

PLATE D-8

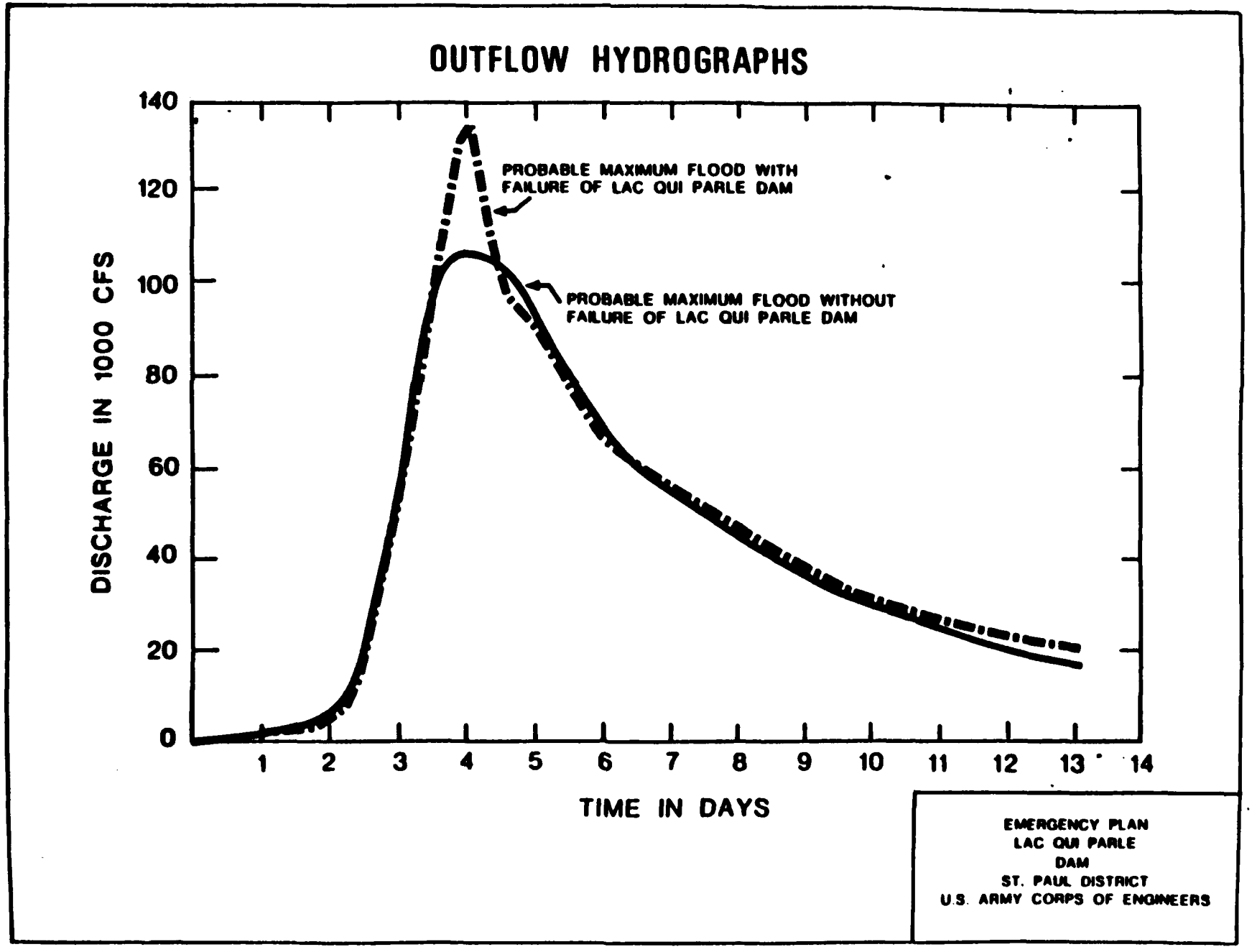

OUTFLOW HYDROGRAPHS
DISCHARGE IN 1000 CFS
140
120
100
80
60
40
20
0
PROBABLE MAXIMUM FLOOD WITH FAILURE OF LAC QUI PARLE DAM
PROBABLE MAXIMUM FLOOD WITHOUT FAILURE OF LAC QUI PARLE DAM
1
2
3
4
5
6
7
8
9
10
11
12
13
14
TIME IN DAYS
EMERGENCY PLAN
LAC QUI PARLE
DAM
ST. PAUL DISTRICT
U.S. ARMY CORPS OF ENGINEERS

PLATE D-9

# COMPARISON OF COMPUTED OUTFLOW RATES

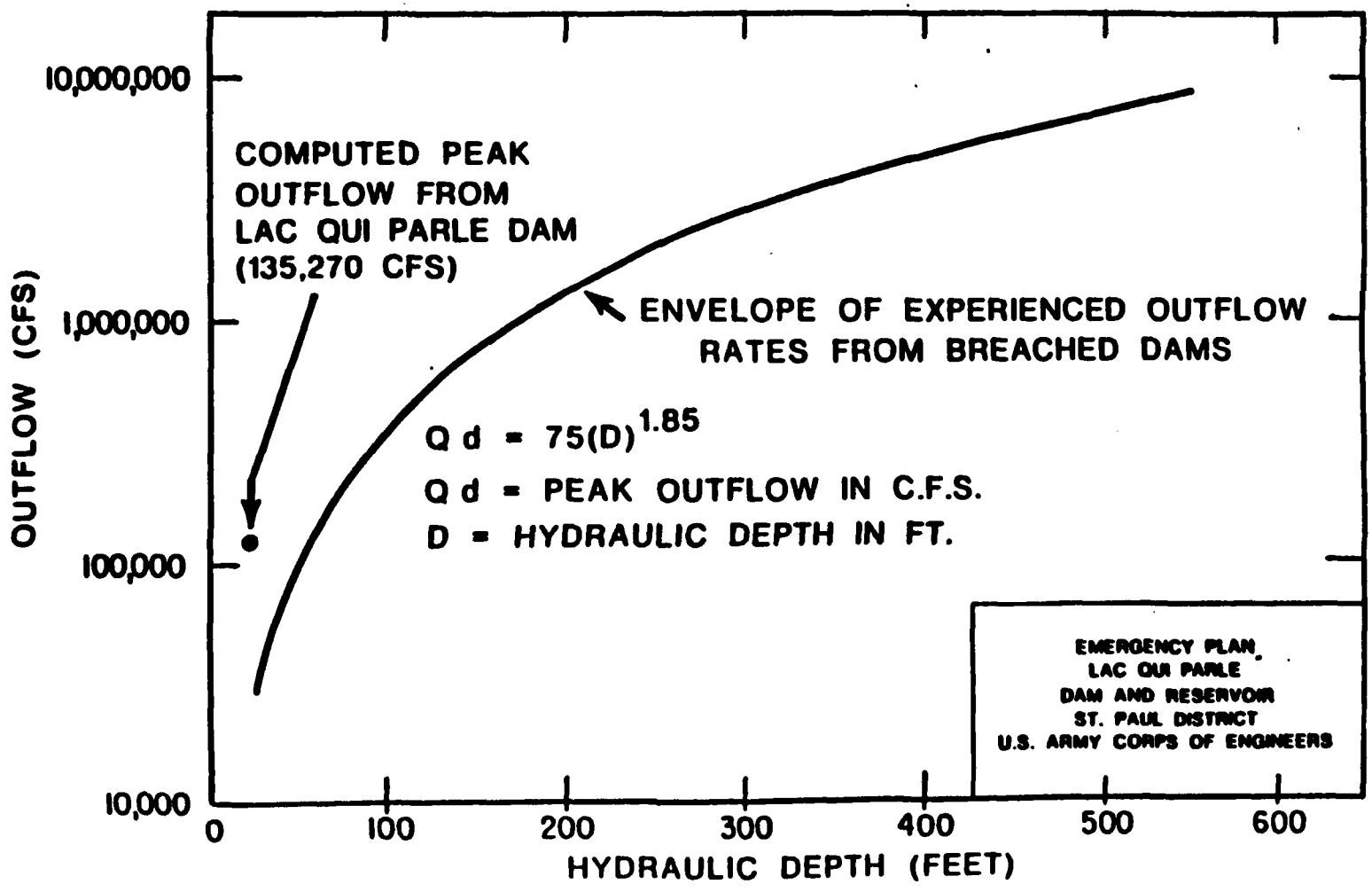



PLATE D-10

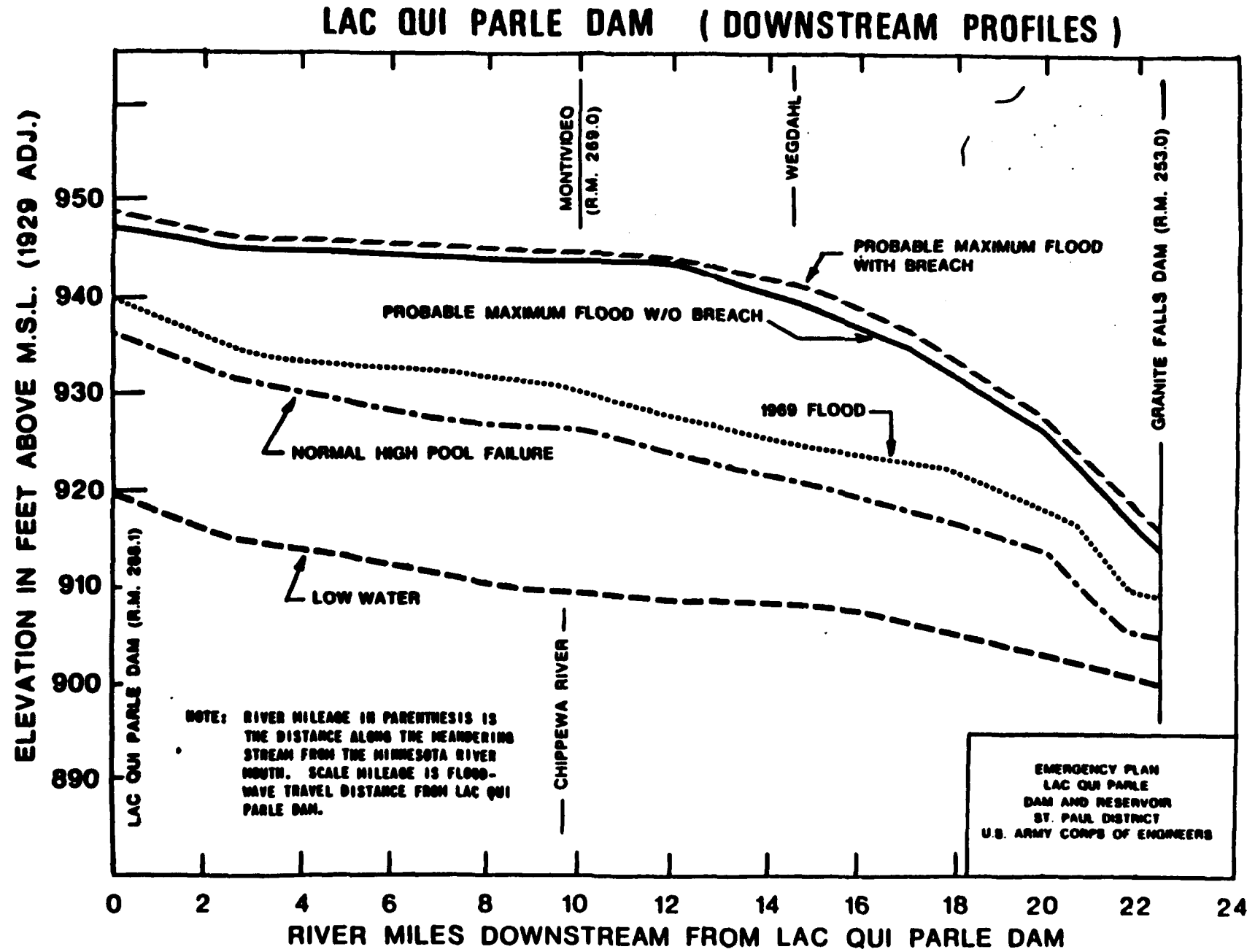

LAC QUI PARLE DAM ( DOWNSTREAM PROFILES )
ELEVATION IN FEET ABOVE M.S.L. (1929 ADJ.)
950
940
930
920
910
900
890
MONTIVIDEO (R.M. 269.0)
WEGDAHL
GRANITE FALLS DAM (R.M. 253.0)
PROBABLE MAXIMUM FLOOD WITH BREACH
PROBABLE MAXIMUM FLOOD W/O BREACH
1969 FLOOD
NORMAL HIGH POOL FAILURE
LOW WATER
LAC QUI PARLE DAM (R.M. 268.1)
CHIPPEWA RIVER
NOTE: RIVER MILEAGE IN PARENTHESIS IS THE DISTANCE ALONG THE MEANDERING STREAM FROM THE MINNESOTA RIVER MOUTH. SCALE MILEAGE IS FLOOD-WAVE TRAVEL DISTANCE FROM LAC QUI PARLE DAM.
EMERGENCY PLAN
LAC QUI PARLE
DAM AND RESERVOIR
ST. PAUL DISTRICT
U.S. ARMY CORPS OF ENGINEERS
0
2
4
6
8
10
12
14
16
18
20
22
24
RIVER MILES DOWNSTREAM FROM LAC QUI PARLE DAM

PLATE D-11

# DISCHARGE AND STAGE HYDROGRAPHS FOR PROBABLE MAXIMUM FLOOD WITH DAM FAILURE AT MONTEVIDEO, MN (RIVER MILE 11.4)

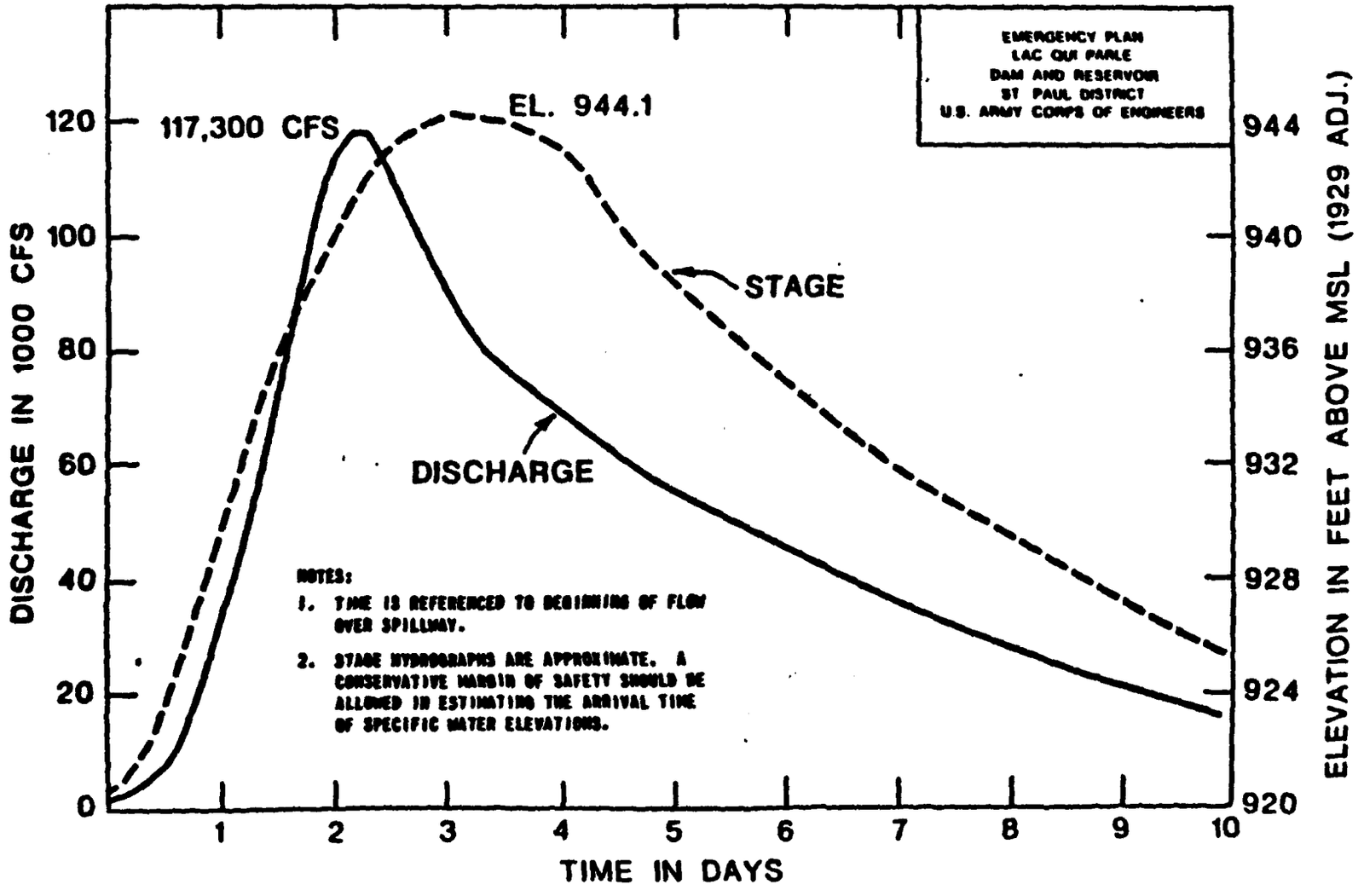



PLATE D-12

# DISCHARGE AND STAGE HYDROGRAPHS FOR PROBABLE MAXIMUM FLOOD WITH DAM FAILURE AT GRANITE FALLS, MN (RIVER MILE 22.2)

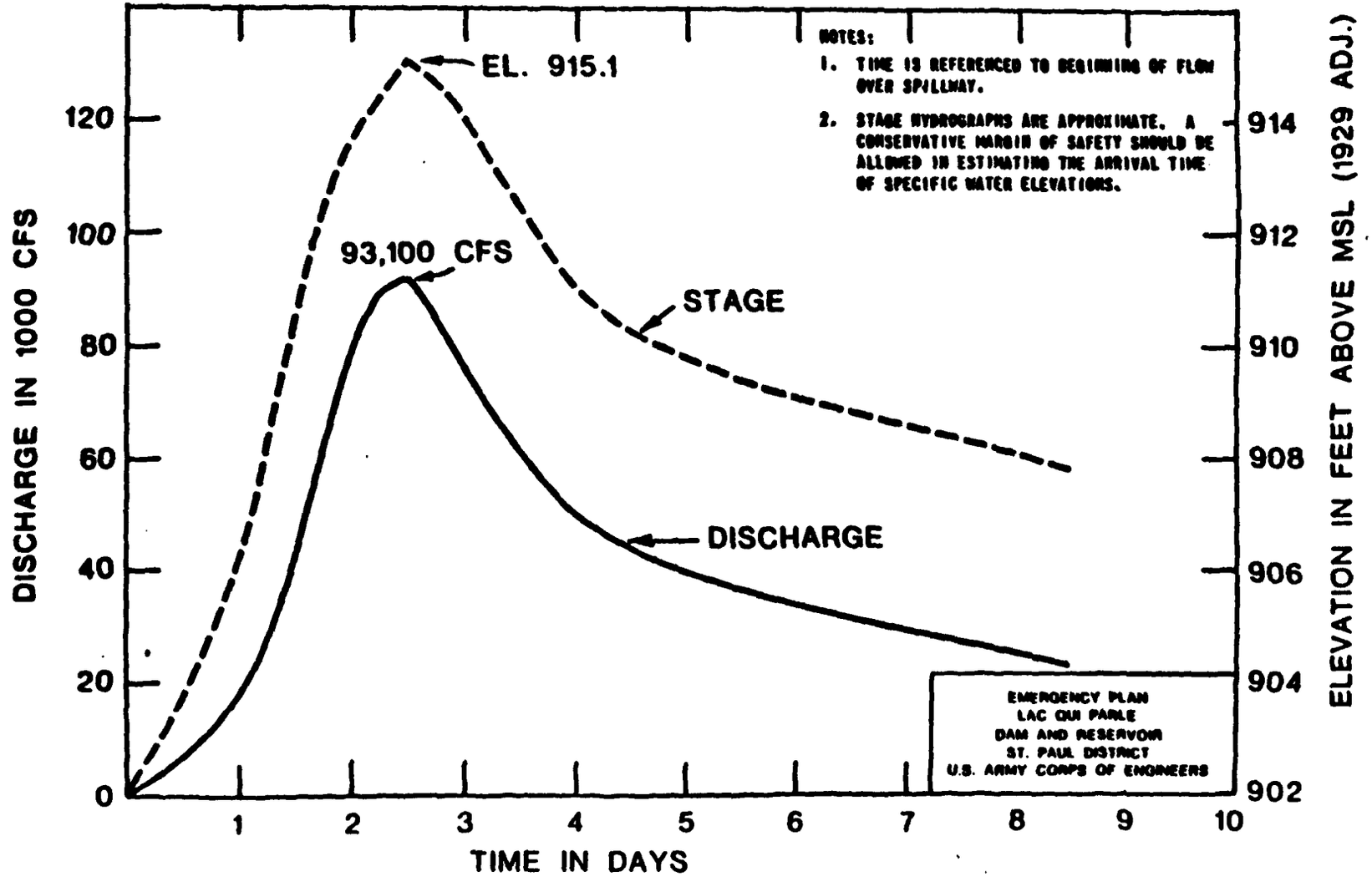



PLATE D-13

# DISCHARGE AND STAGE HYDROGRAPHS FOR FAILURE AT NORMAL HIGH POOL LEVEL AT MONTEVIDEO, MN (RIVER MILE 11.4)

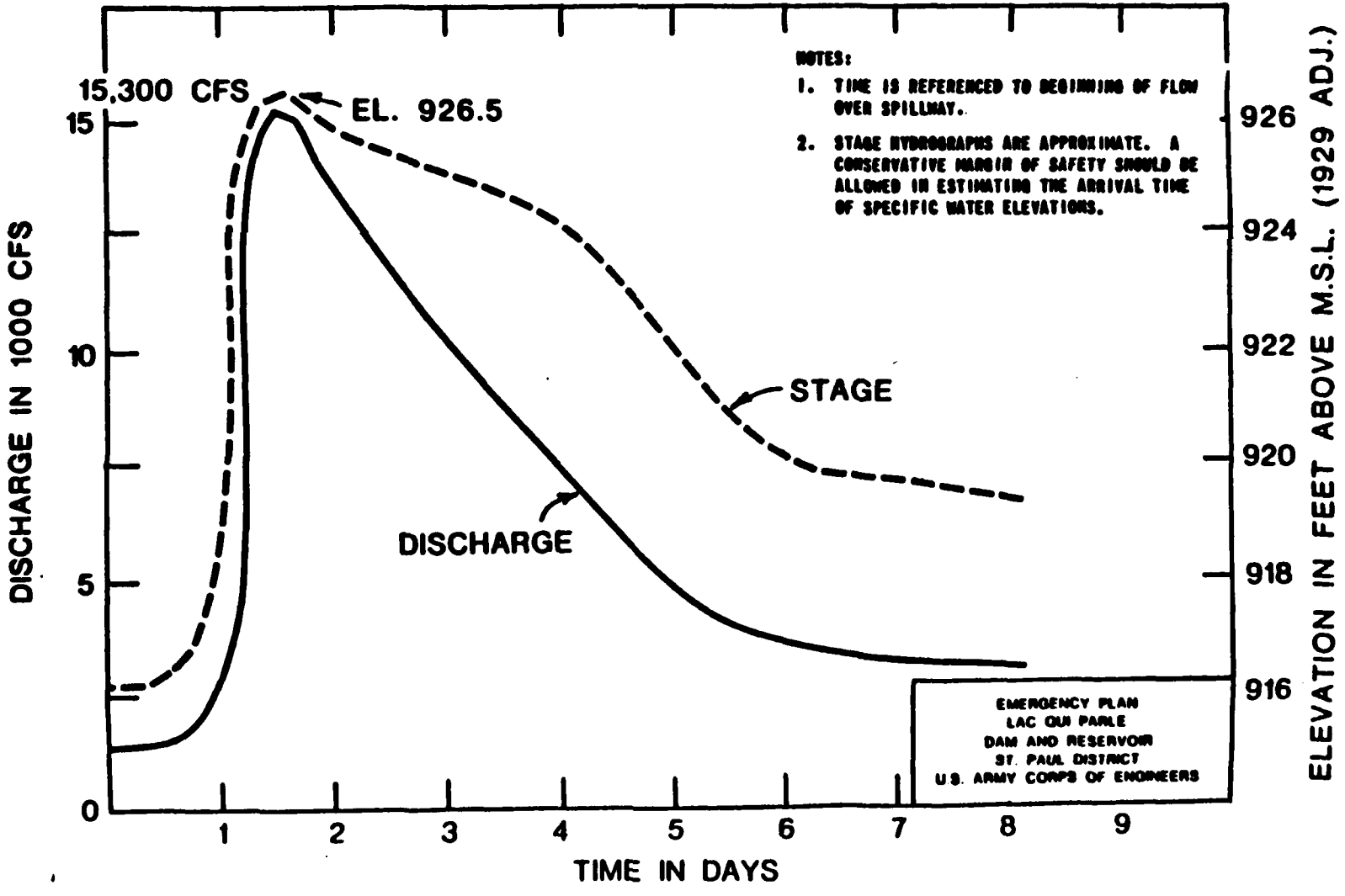



PLATE D-14

# EMERGENCY PLAN

# FOR

# LAC QUI PARLE FLOOD CONTROL PROJECT

## APPENDIX E

## INUNDATION MAPS
## MARSH LAKE DAM

**Prepared By**
**ST. PAUL DISTRICT**
**U.S. ARMY CORPS OF ENGINEERS**

**OCTOBER 1988**

## TABLE OF CONTENTS



## LIST OF PLATES

# FLOOD EMERGENCY PLAN

# FOR

# MARSH LAKE DAM AND RESERVOIR

## E-1. Introduction

This appendix presents the Inundation Maps and other hydraulic data for the area downstream of the Marsh Lake Dam for the cases of Probable Maximum Flood with and without dam failure and failure at Normal High Pool Level.

## E-2. Explanation of Plates

The attached map (Plate E-1) indicate the area which would be flooded under the hypothesized conditions of: a) occurrence of a probable maximum flood (PMF) at Marsh Lake Dam; and b) occurrence of a failure of the dam concurrent with a probable maximum flood. The possibility is extremely remote that either condition will occur. Pertinent hydraulic data associated with the reservoir and area downstream of Marsh Lake Dam are shown on Plates E-2 through E-6 inclusive.

Preparation of the maps does not reflect on the safety or integrity of Marsh Lake Dam. They have been prepared as part of a national program to prepare similar maps for all Federal Dams.

## E-3. Use of Maps

The attached maps provide a basis for evaluation existing evacuation plans for the affected area and development of any further plans which are needed. The Corps of Engineers recommends that such evaluations be made and any needed supplemental plans be developed. Information on evacuation planning and examples of evacuation plans are available from the Corps of Engineers.

The general procedure for use of the attached maps is as follows:

a. Determine the portion of your area of concern which would be affected by inundation or isolation.

b. Identify routes which would be used for movement of people from each part of the area to be evacuated.

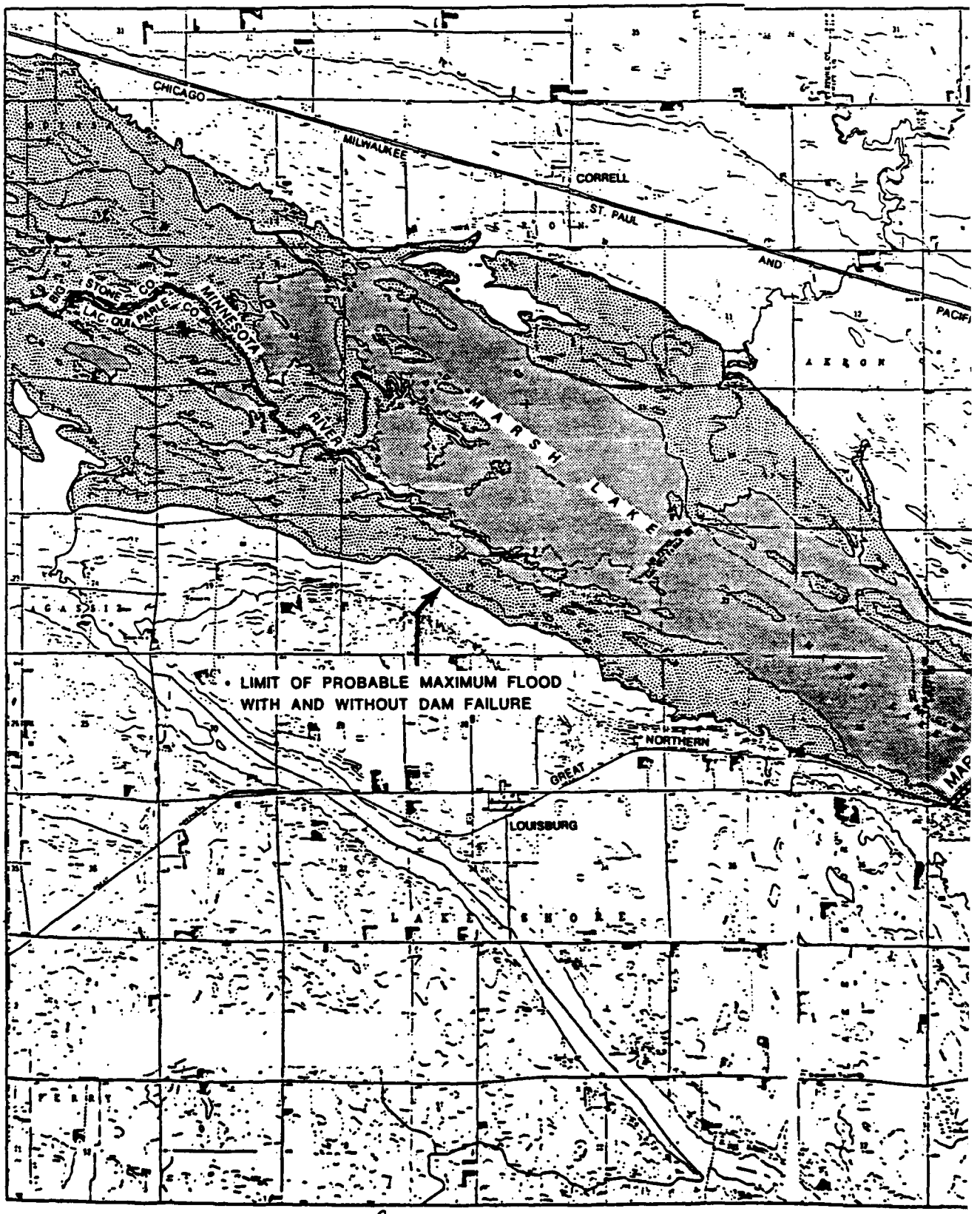
c. Identify the amount of time available for evacuation.

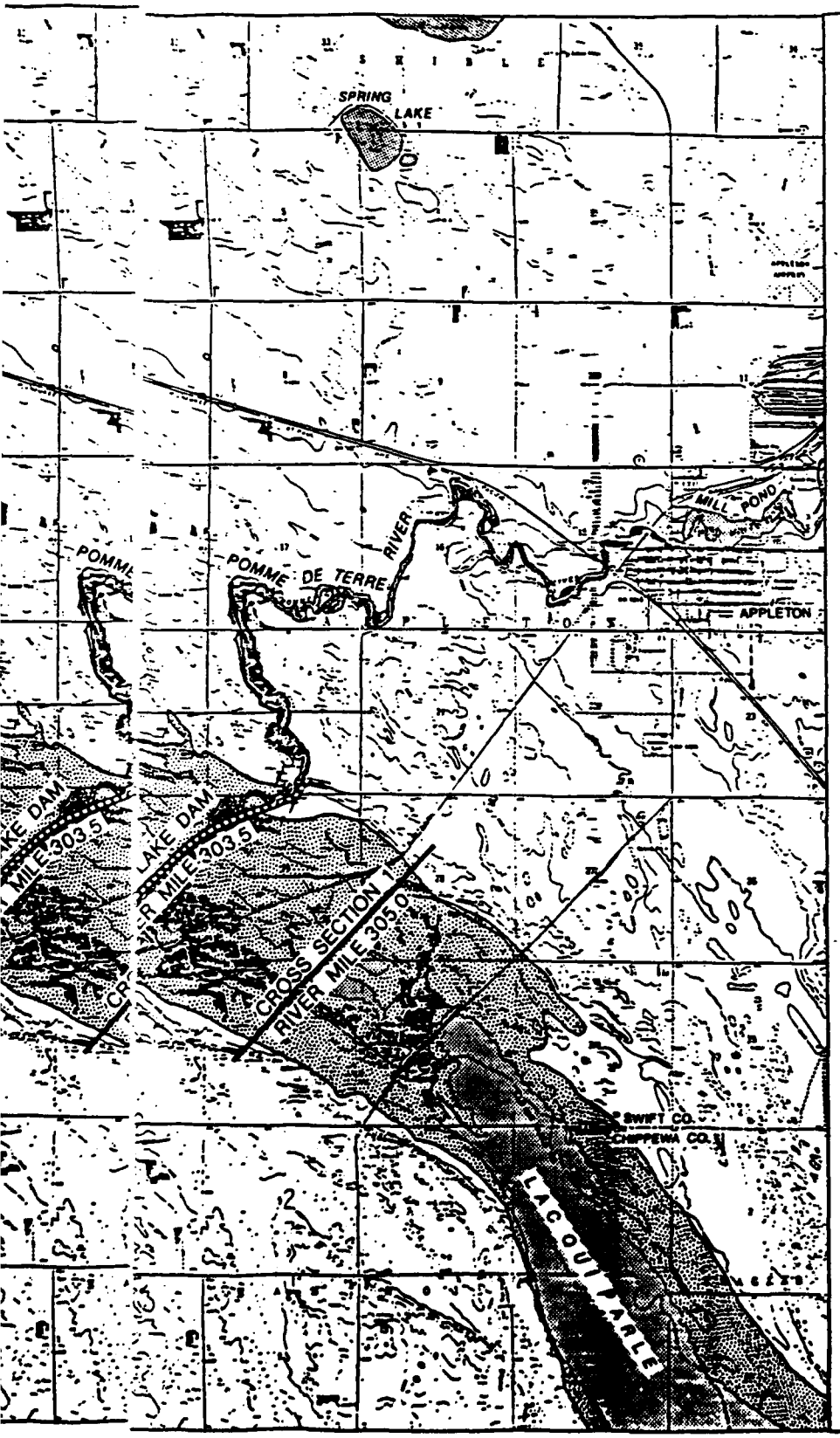
d. Use the information to assess whether existing evacuation plans cover all of the affected area and will provide for timely evacuation.

E-4. Definition of Terms

| | |
|---|---|
| River Mile | The distance along the channel of the Minnesota River measured along the channel downstream from the dam. |
| Peak elevation | The computed maximum water surface elevation which would be reached at a location due to assumed conditions. |
| Peak time | Elapsed time* after assumed event until peak discharge occurs. |
| NGVD | National Geodetic Vertical Datum (distance above 1929 mean sea level). |
| Probable Maximum Flood | The theoretical maximum flow that can be expected from the watershed. |
| Dam failure | Any condition resulting in the uncontrolled release of water other that over or through an uncontrolled spillway or outlet works. |
| Cross Section | Point at which the shape of a stream channel or valley is measured, usually in a direciton perpendicualr to the direction of flow. |

*Elapsed time for the case of Probable Maximum Flood without failure is measured from the time at which the reservoir level exceeds the top of the flood control pool. Elapsed time for the case of Probable Maximum Flood with failure is measured from the beginning of the actual dam failure.


CHICAGO
MILWAUKEE
ST. PAUL
AND
CORRELL
BIG STONE CO.
LAC QUI PARLE CO.
MINNESOTA
RIVER
MARSH LAKE
LIMIT OF PROBABLE MAXIMUM FLOOD
WITH AND WITHOUT DAM FAILURE
NORTHERN
GREAT
LOUISBURG
LAKE SHORE




-N-

LEGEND

5 ——— 5 CROSS SECTION

LIMIT OF PROBABLE MAXIMUM FLOOD WITH AND WITHOUT DAM FAILURE

1 1/2 0 1 MILE

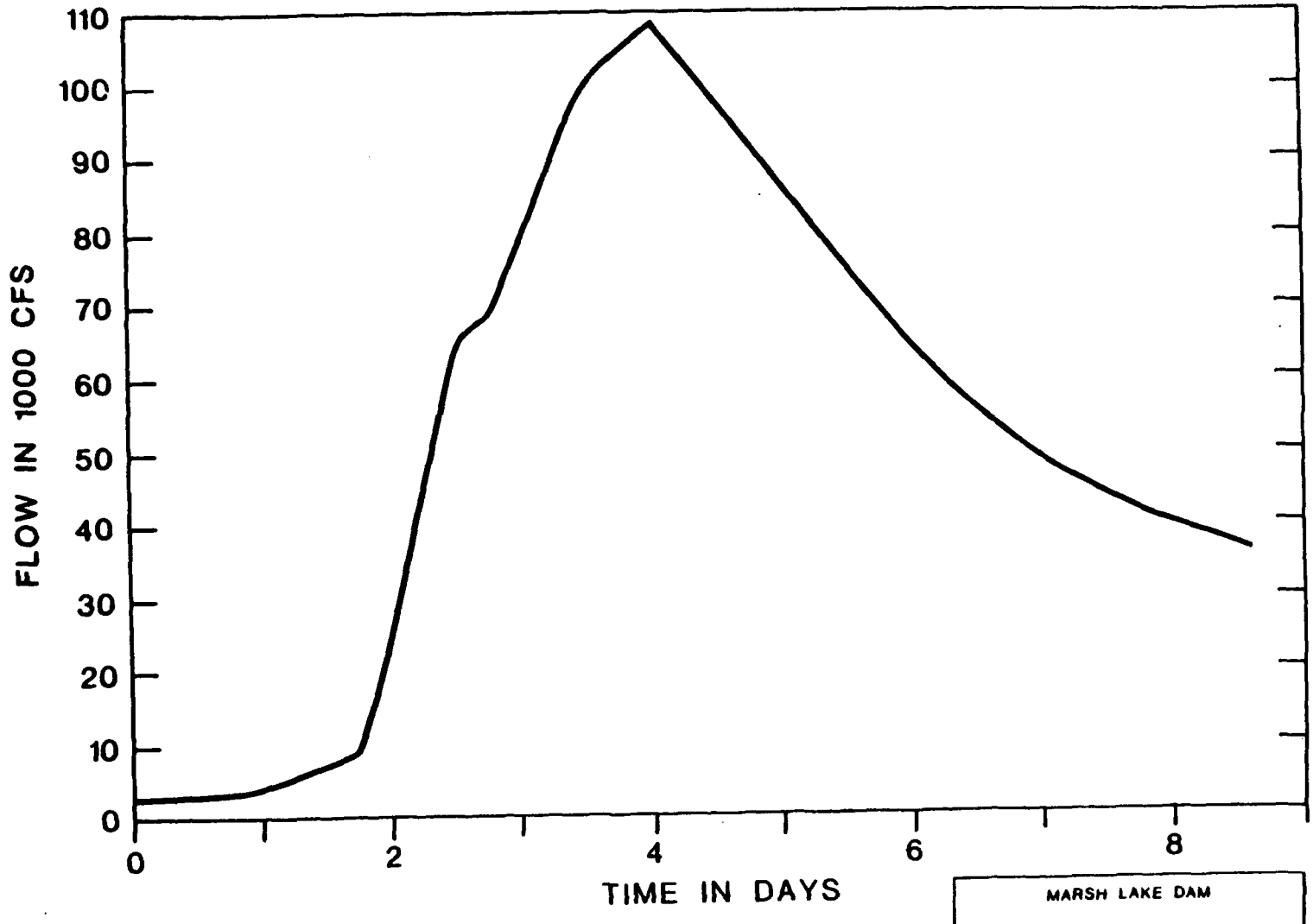
U.S. ARMY ENGINEERING DISTRICT, ST. PAUL
CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

MARSH LAKE DAM
MINNESOTA RIVER, MINNESOTA
INUNDATION MAP

(2)

PLATE E-1

# PROBABLE MAXIMUM FLOOD DISCHARGE HYDROGRAPH



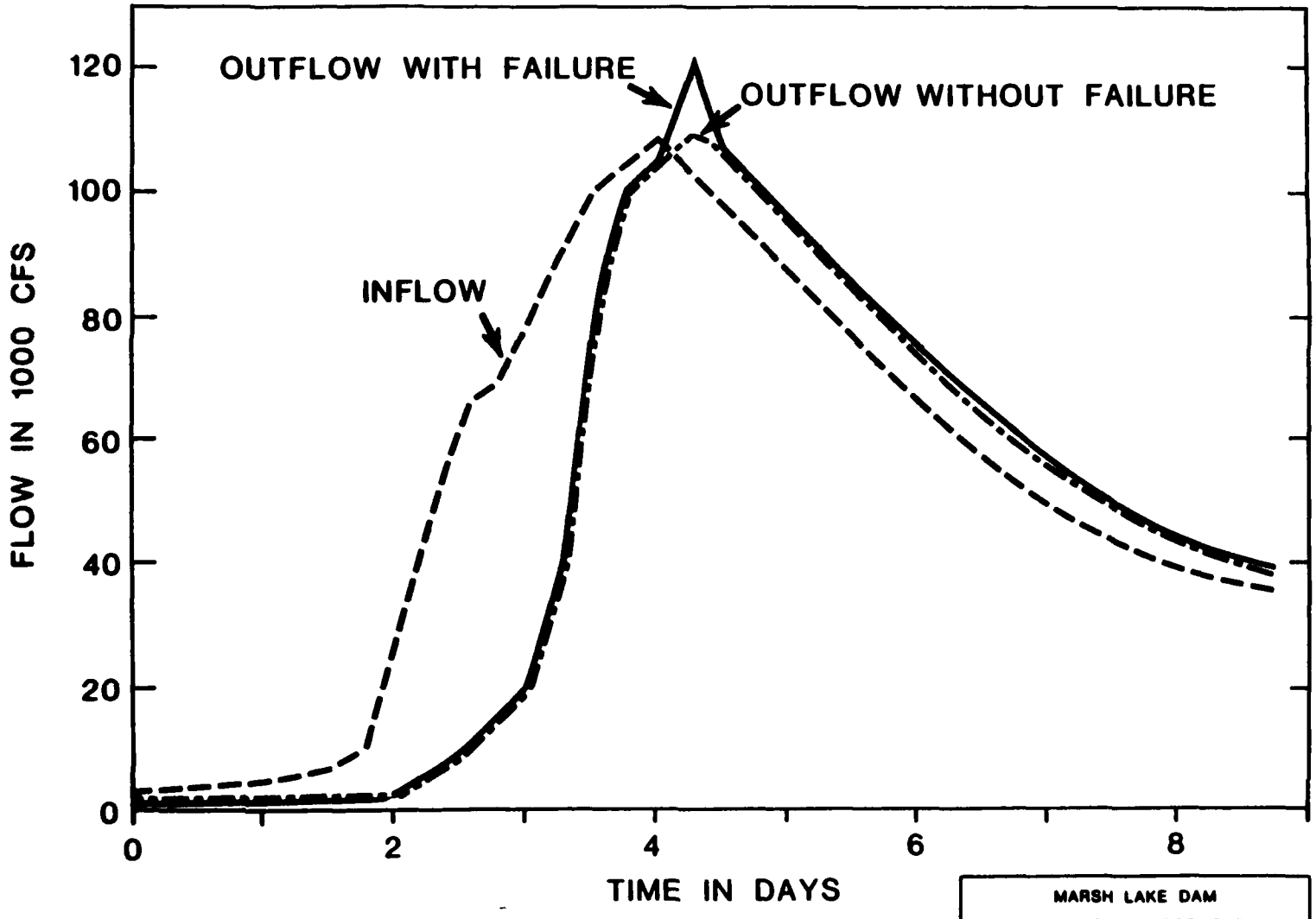

MARSH LAKE DAM

PMF DISCHARGE HYDROGRAPH

ST. PAUL DISTRICT
U.S. ARMY CORPS OF ENGINEERS

PLATE E-2

# PROBABLE MAXIMUM FLOOD RISK ASSESSMENT DISCHARGE HYDROGRAPH



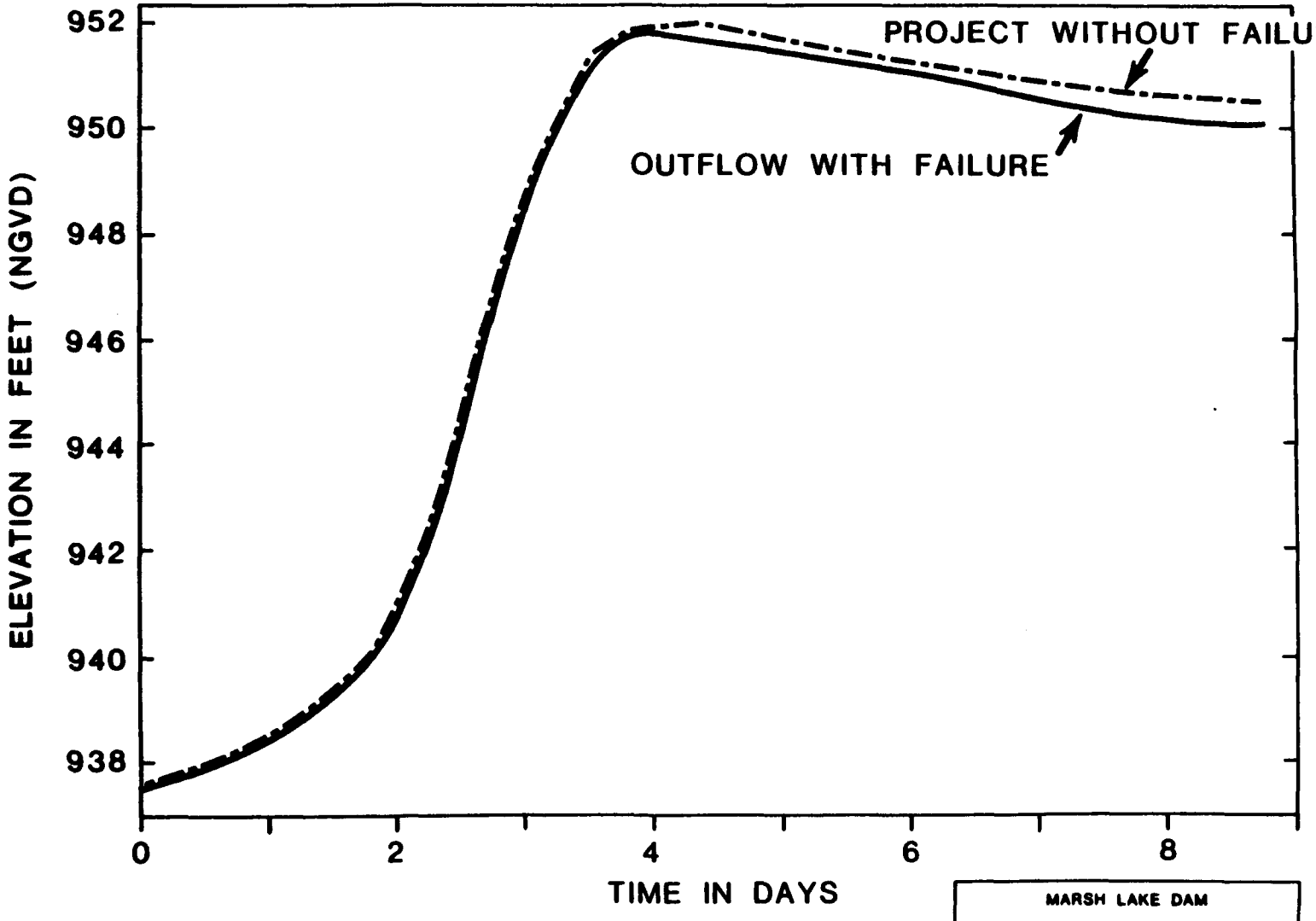

MARSH LAKE DAM

PMF RISK ASSESSMENT
DISCHARGE HYDROGRAPH

ST. PAUL DISTRICT
U.S. ARMY CORPS OF ENGINEERS

PLATE E-3

# PROBABLE MAXIMUM FLOOD RISK ASSESSMENT ELEVATION HYDROGRAPH




MARSH LAKE DAM

PMF RISK ASSESSMENT
ELEVATION DISCHARGE

ST. PAUL DISTRICT
U.S. ARMY CORPS OF ENGINEERS

PLATE E-4

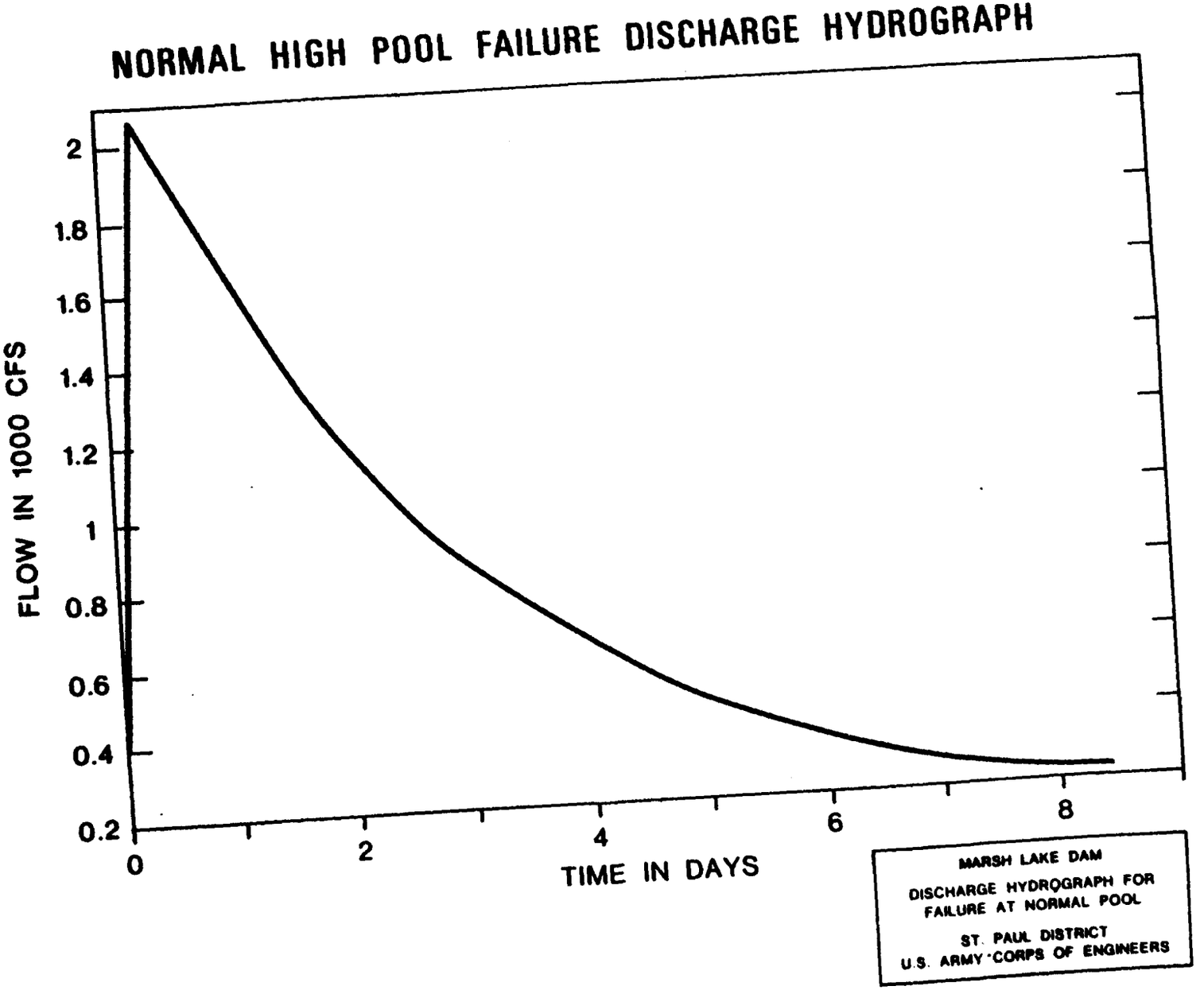
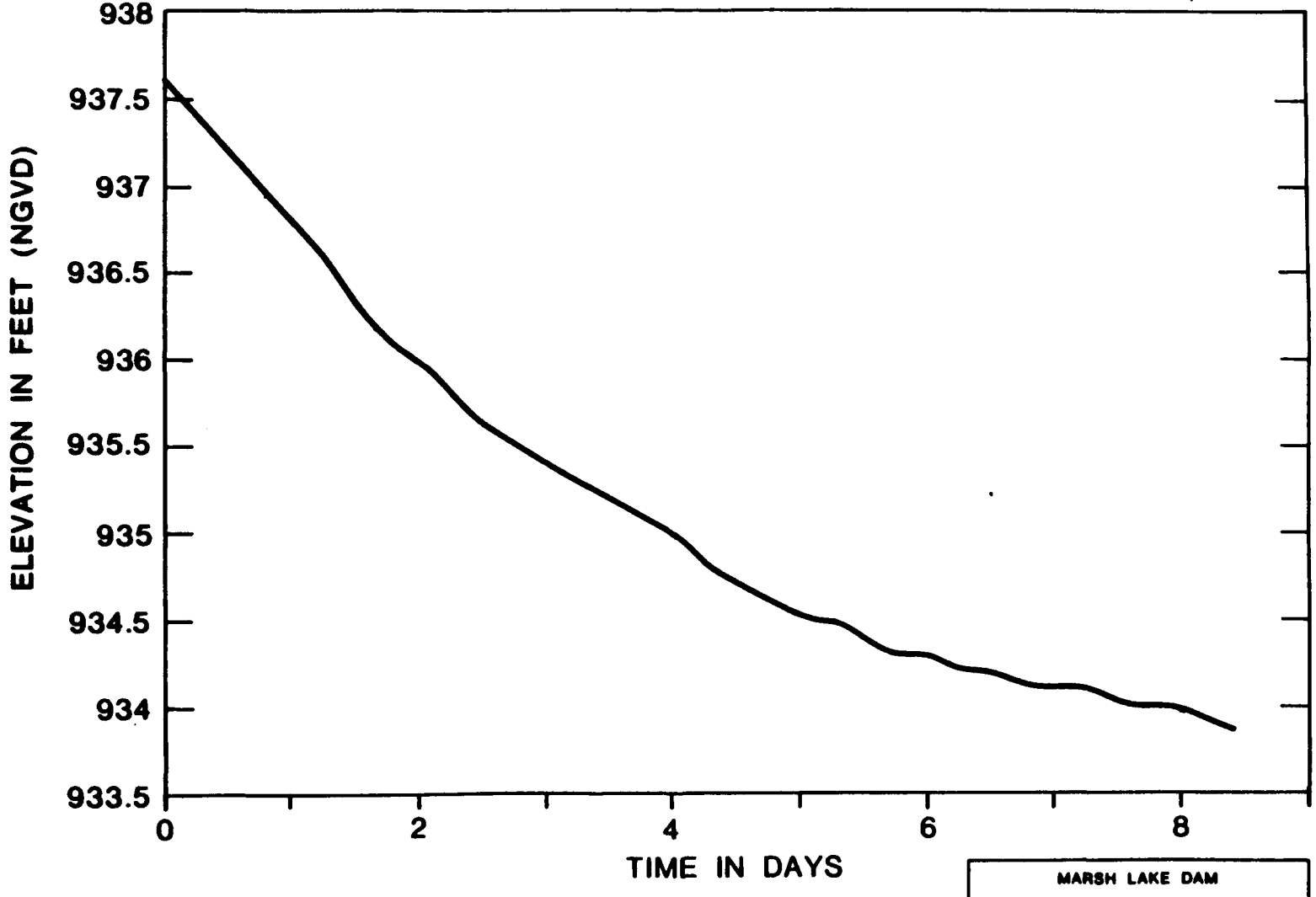

NORMAL HIGH POOL FAILURE DISCHARGE HYDROGRAPH
FLOW IN 1000 CFS
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
2
4
6
8
TIME IN DAYS
MARSH LAKE DAM
DISCHARGE HYDROGRAPH FOR FAILURE AT NORMAL POOL
ST. PAUL DISTRICT
U.S. ARMY CORPS OF ENGINEERS

PLATE E-5

# NORMAL HIGH POOL FAILURE ELEVATION HYDROGRAPH




MARSH LAKE DAM

ELEVATION HYDROGRAPH FOR FAILURE AT NORMAL POOL

ST. PAUL DISTRICT
U.S. ARMY CORPS OF ENGINEERS

PLATE E-6

# EMERGENCY PLAN

# FOR

# LAC QUI PARLE FLOOD CONTROL PROJECT

## APPENDIX F

## INUNDATION MAPS
## CHIPPEWA DIVERSION DAM

Prepared By
ST. PAUL DISTRICT
U.S. ARMY CORPS OF ENGINEERS

OCTOBER 1988

## TABLE OF CONTENTS



## LIST OF PLATES

# FLOOD EMERGENCY PLAN

# FOR

# CHIPPEWA DIVERSION DAM AND RESERVOIR

## F-1. Introduction

This appendix presents the Inundation Maps and other hydraulic data for the area downstream of the Chippewa Diversion Dam for the cases of Probable Maximum Flood with and without dam failure and failure at Normal High Pool Level.

## F-2. Explanation of Plates

The attached maps (Plate F-1 and F-2) indicate the area which would be flooded under the hypothesized conditions of: a) occurrence of a probable maximum flood (PMF) at Chippewa Diversion Dam and b) occurrence of a failure of the dam concurrent with a probable maximum flood. The possibility is extremely remote that either condition will occur. Pertinent hydraulic data assiciated with the reservoir and area downstream of Chippewa Diversion Dam are shown on Plates F-3 through F-6 inclusive.

Preparation of the maps does not reflect on the safety or integrity of Chippewa Diversion Dam. They have been prepared as part of a national program to prepare similar maps for all Federal Dams.

## F-3. Use of Maps

The attached maps provide a basis for evaluation existing evacuation plans for the affected area and development of any further plans which are needed. The Corps of Engineers recommends that such evaluations be made and any needed supplemental plans be developed. Information on evacuation planning and examples of evacuation plans are available from the Corps of Engineers.

The general procedure for use of the attached maps is as follows:

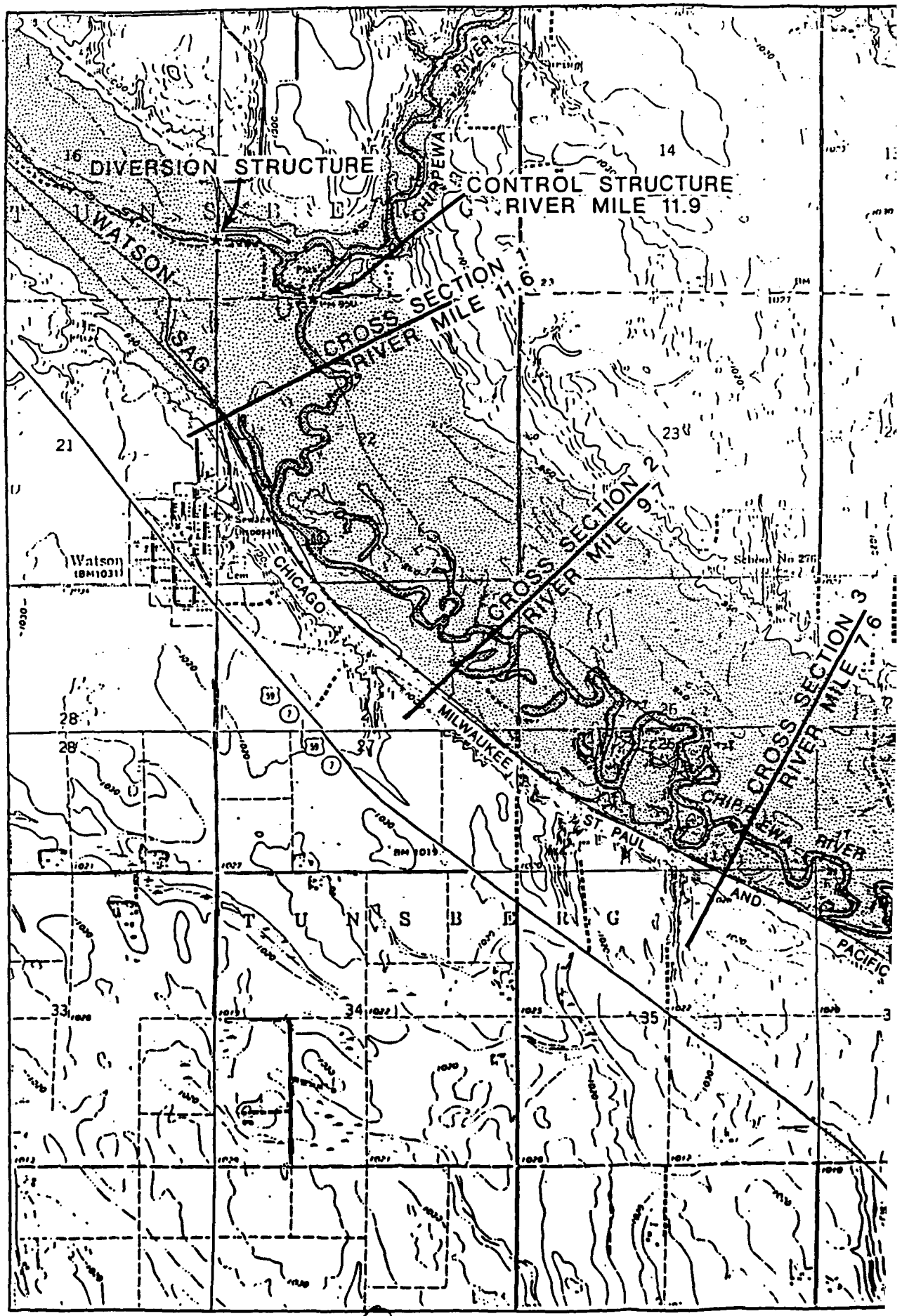
a. Determine the portion of your area of concern which would be affected by inundation or isolation.

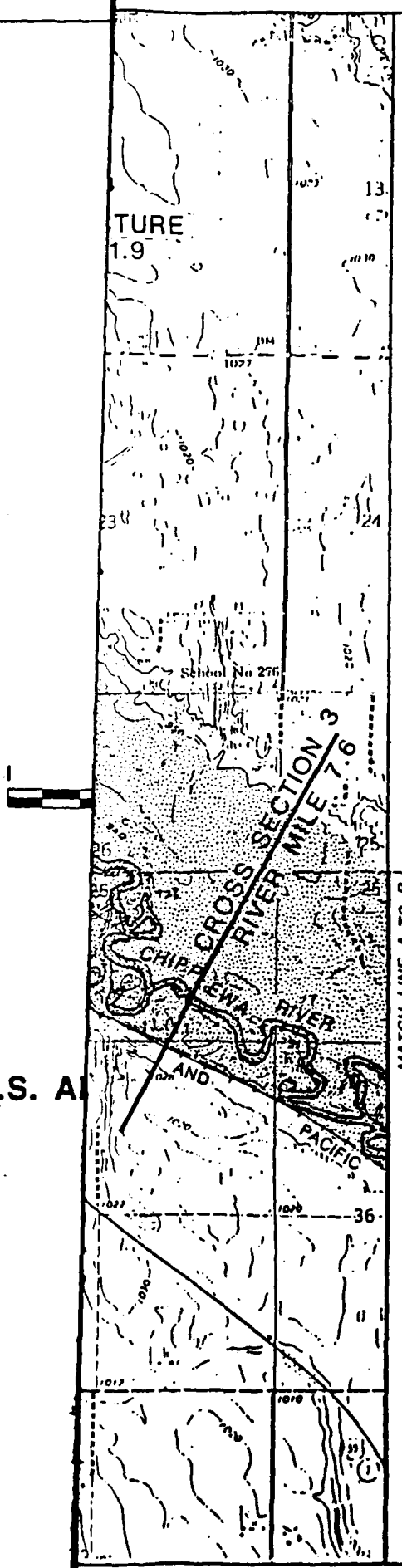
b. Identify routes which would be used for movement of people from each part of the area to be evacuated.
c. Identify the amount of time available for evacuation.

d. Use the ingormation to assess whether existing evacuation plans cover all of the affected area and will provide for timely evacuation.

F-4. Definition of Terms

| | |
|---|---|
| River Mile | The distance along the channel of the Minnesota River measured along the channel downstream from the dam. |
| Peak elevation | The computed maximum water surface elevation which would be reached at a location due to assumed conditions. |
| Peak time | Elapsed time* after assumed event until peak discharge occurs. |
| NGVD | National Geodetic Vertical Datum (distance above 1929 mean sea level). |
| Probable Maximum Flood | The theoretical maximum flow that can be expected from the watershed. |
| Dam failure | Any condition resulting in the uncontrolled release of water other that over or through an uncontrolled spillway or outlet works. |
| Cross Section | Point at which the shape of a stream channel or valley is measured, usually in a direciton perpendicualr to the direction of flow. |


DIVERSION STRUCTURE
CONTROL STRUCTURE
RIVER MILE 11.9
CHIPPEWA RIVER
WATSON SAG
CROSS SECTION 1
RIVER MILE 11.6
CROSS SECTION 2
RIVER MILE 9.7
CROSS SECTION 3
RIVER MILE 7.6
Watson
CHICAGO
MILWAUKEE
ST. PAUL
AND
PACIFIC
T 31 N R 8 E
T 31 N R 9 E
16
14
21
22
23
28
27
26
25
33
34
35




-N-

## LEGEND

LIMIT OF PROBABLE MAXIMUM FLOOD WITH AND WITHOUT DAM FAILURE

5 ——— 5 CROSS SECTION

1 1/2 0 1 MILE

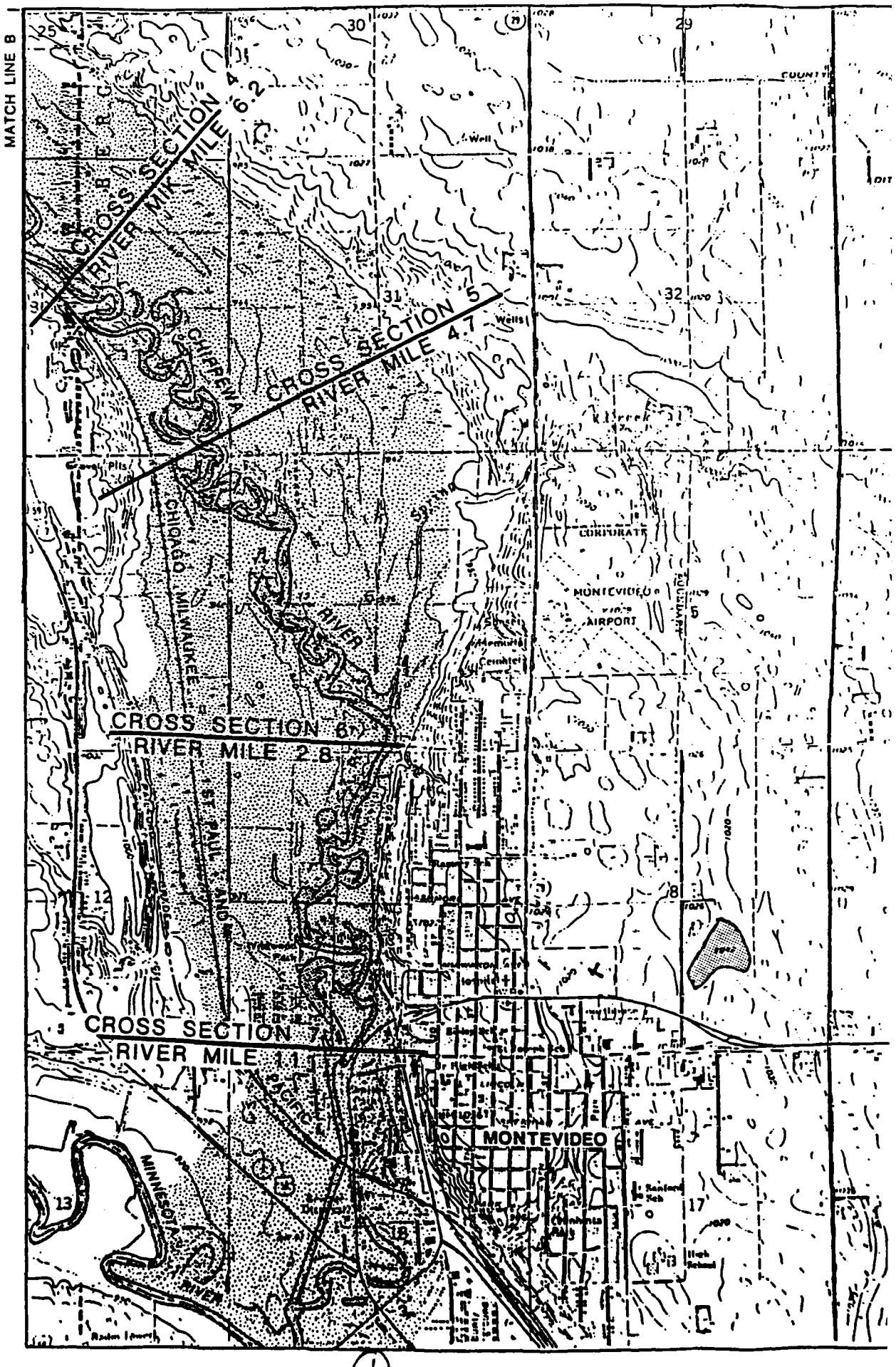
U.S. AI

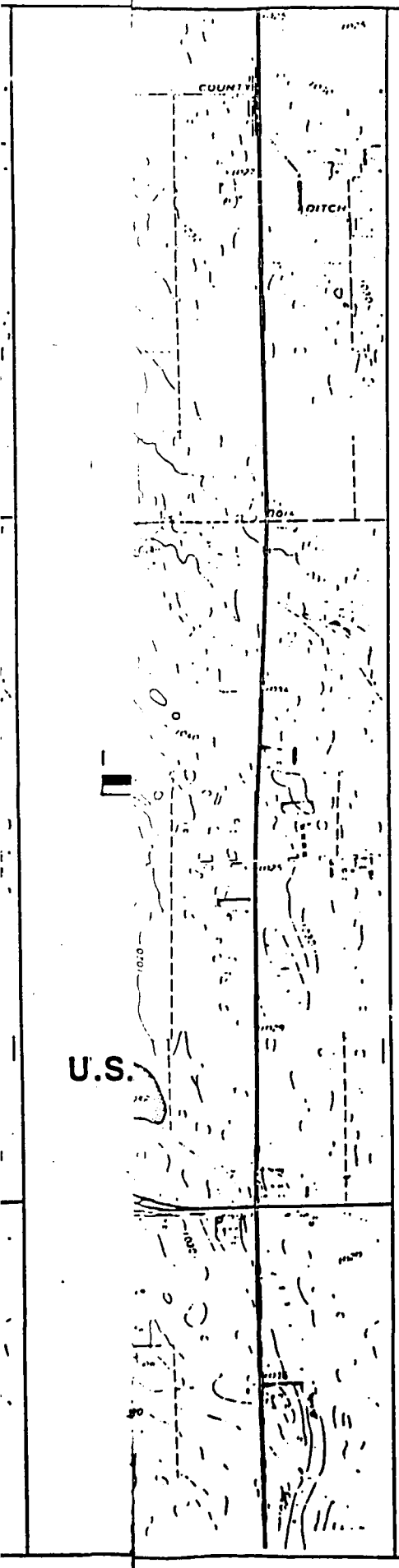
## U.S. ARMY ENGINEERING DISTRICT, ST. PAUL
## CORPS OF ENGINEERS
## ST. PAUL, MINNESOTA

# CHIPPEWA DIVERSION
# CHIPPEWA RIVER, MINNESOTA
# INUNDATION MAP

(2)

PLATE F-1


MATCH LINE B
CROSS SECTION 4
RIVER MILE 6.2
CROSS SECTION 5
RIVER MILE 4.7
CHIPPEWA
CHICAGO MILWAUKEE
MINNESOTA RIVER
CROSS SECTION 6
RIVER MILE 2.8
ST. PAUL AND
CROSS SECTION 7
RIVER MILE 1.1
MONTEVIDEO
AIRPORT
MINNESOTA RIVER
30
29
31
32
25
5
8
12
13
17
18



-N-

## LEGEND

LIMIT OF PROBABLE MAXIMUM FLOOD WITH AND WITHOUT DAM FAILURE

5 ——— 5 CROSS SECTION

1 0 1/2 1 MILE

U.S.

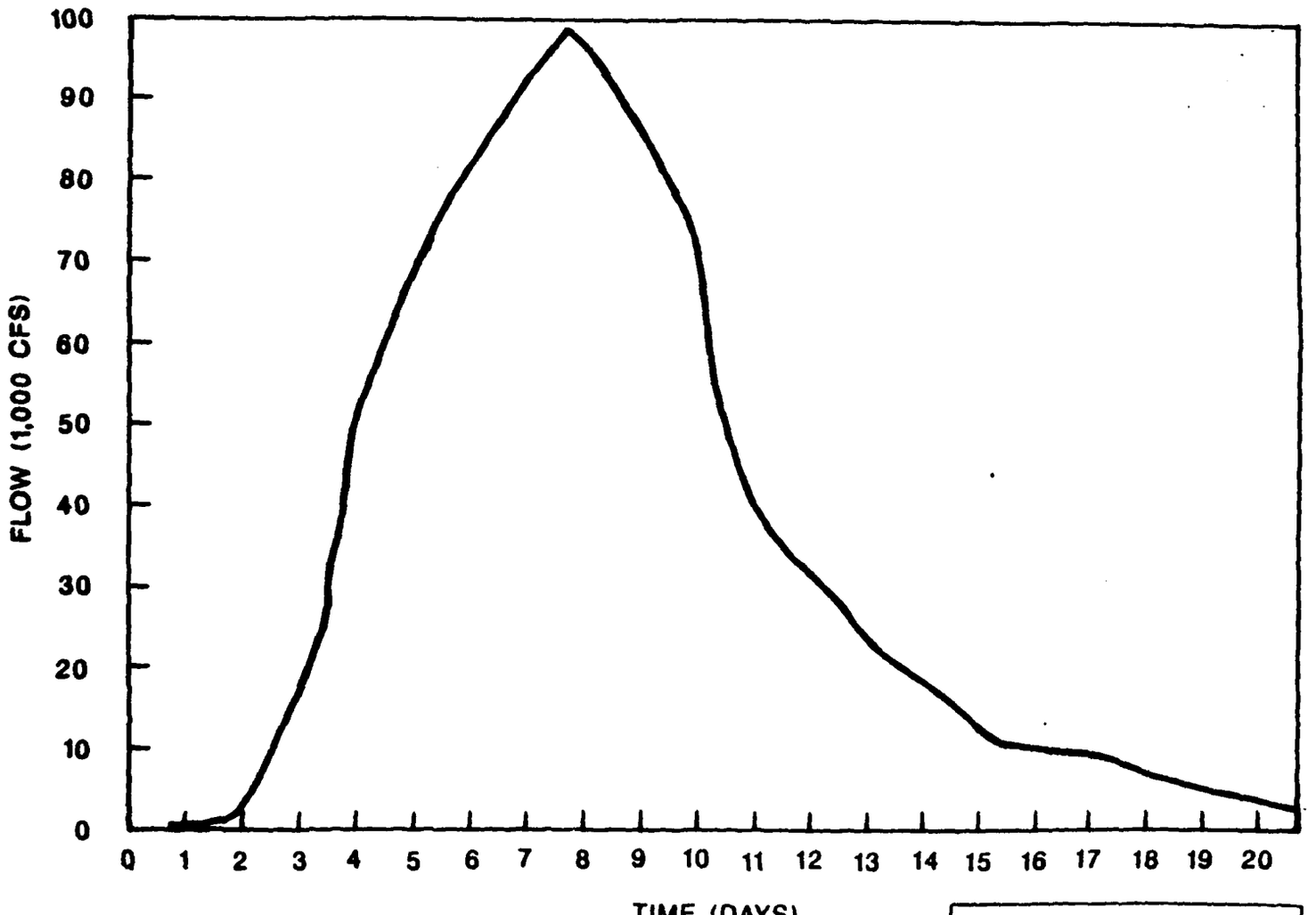
# U.S. ARMY ENGINEERING DISTRICT, ST. PAUL
# CORPS OF ENGINEERS
# ST. PAUL, MINNESOTA

## CHIPPEWA DIVERSION
## CHIPPEWA RIVER, MINNESOTA
## INUNDATION MAP

(2)

PLATE F-2

# PMF INFLOW HYDROGRAPH



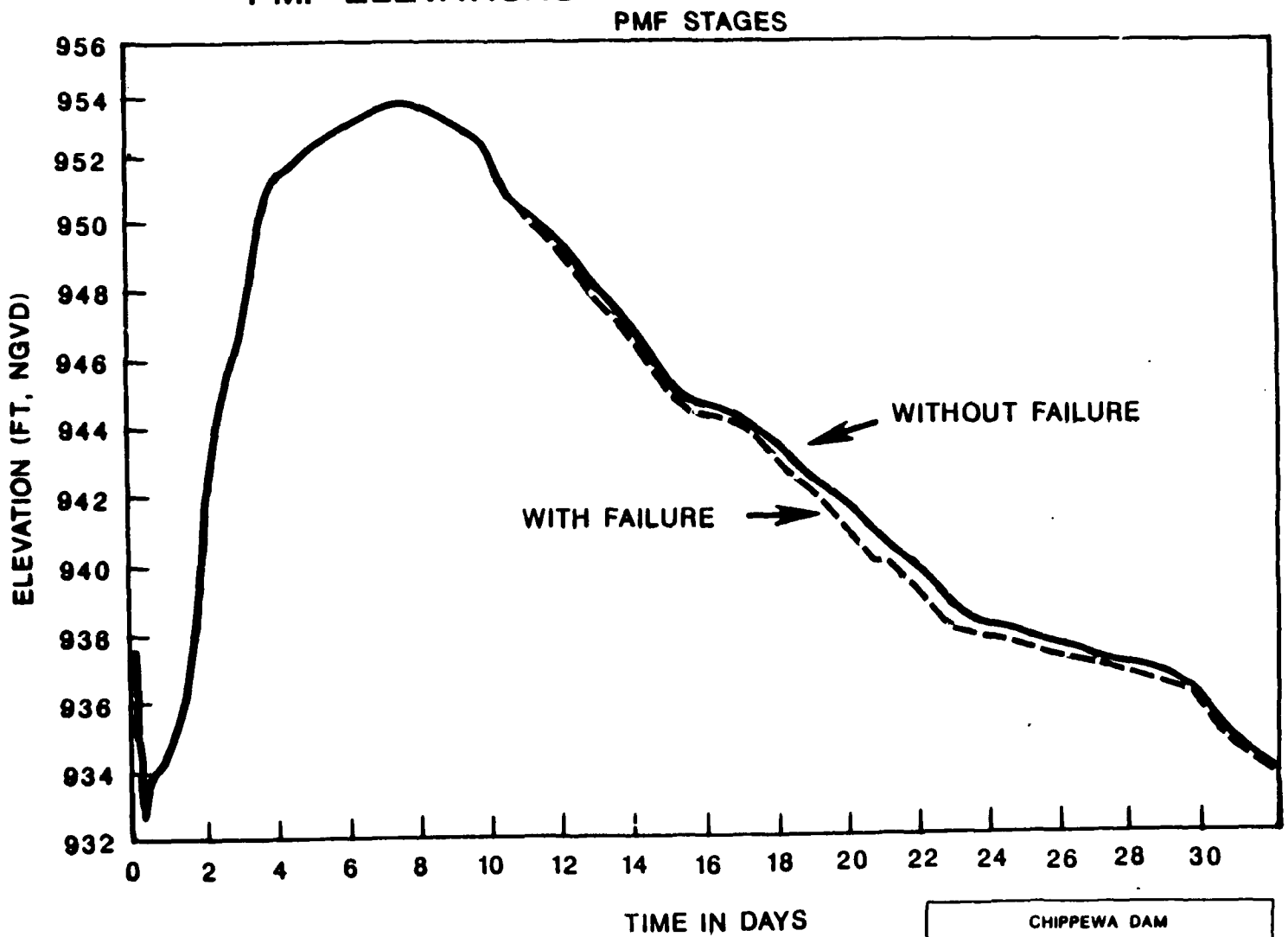

CHIPPEWA DAM

PMF INFLOW HYDROGRAPH

ST. PAUL DISTRICT

PLATE

# PMF ELEVATIONS WITH AND WITHOUT FAILURE



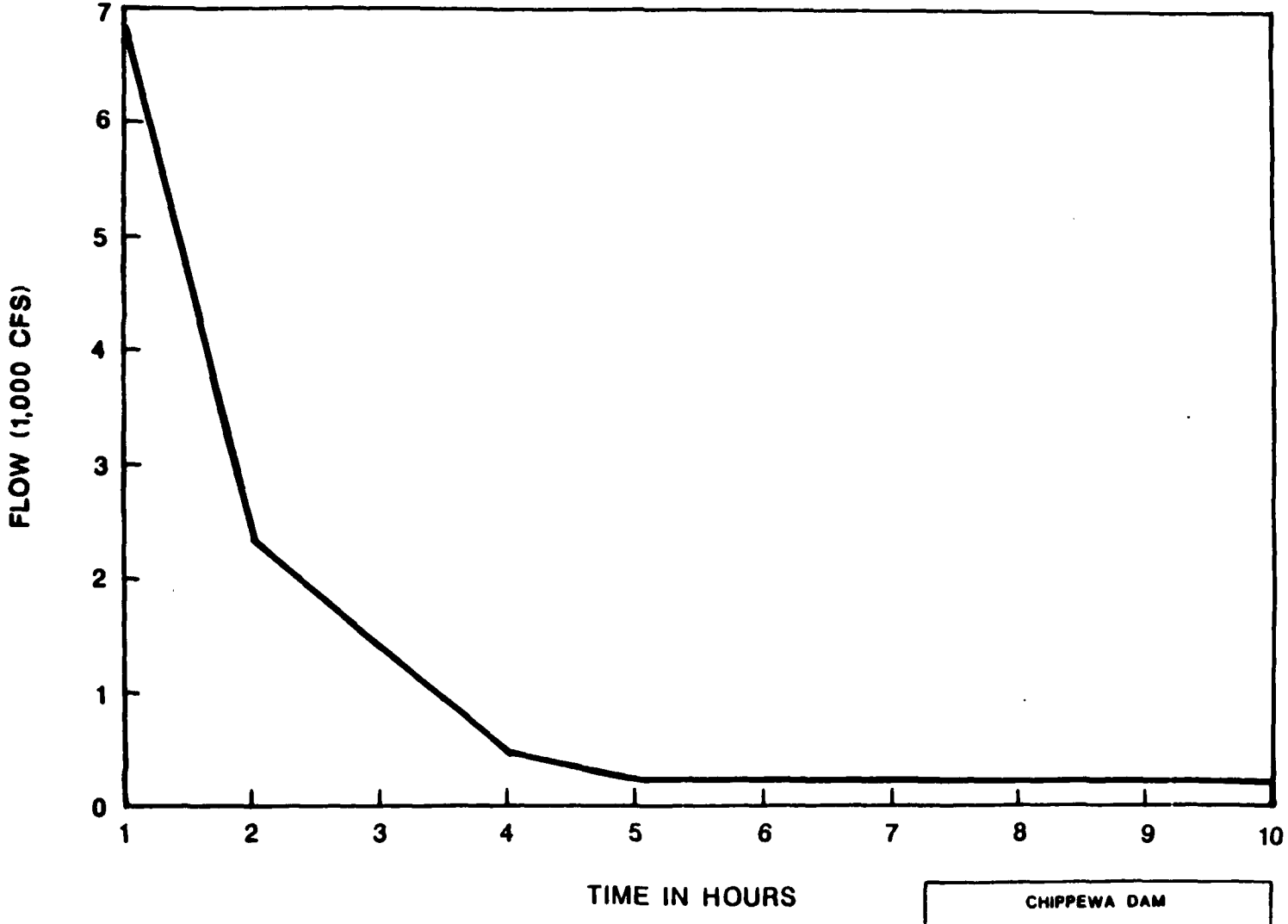

CHIPPEWA DAM

PMF ELEVATIONS WITH AND WITHOUT FAILURE

ST. PAUL DISTRICT
U.S. ARMY CORPS OF ENGINEERS

PLATE F-4

# NORMAL HIGH POOL FAILURE

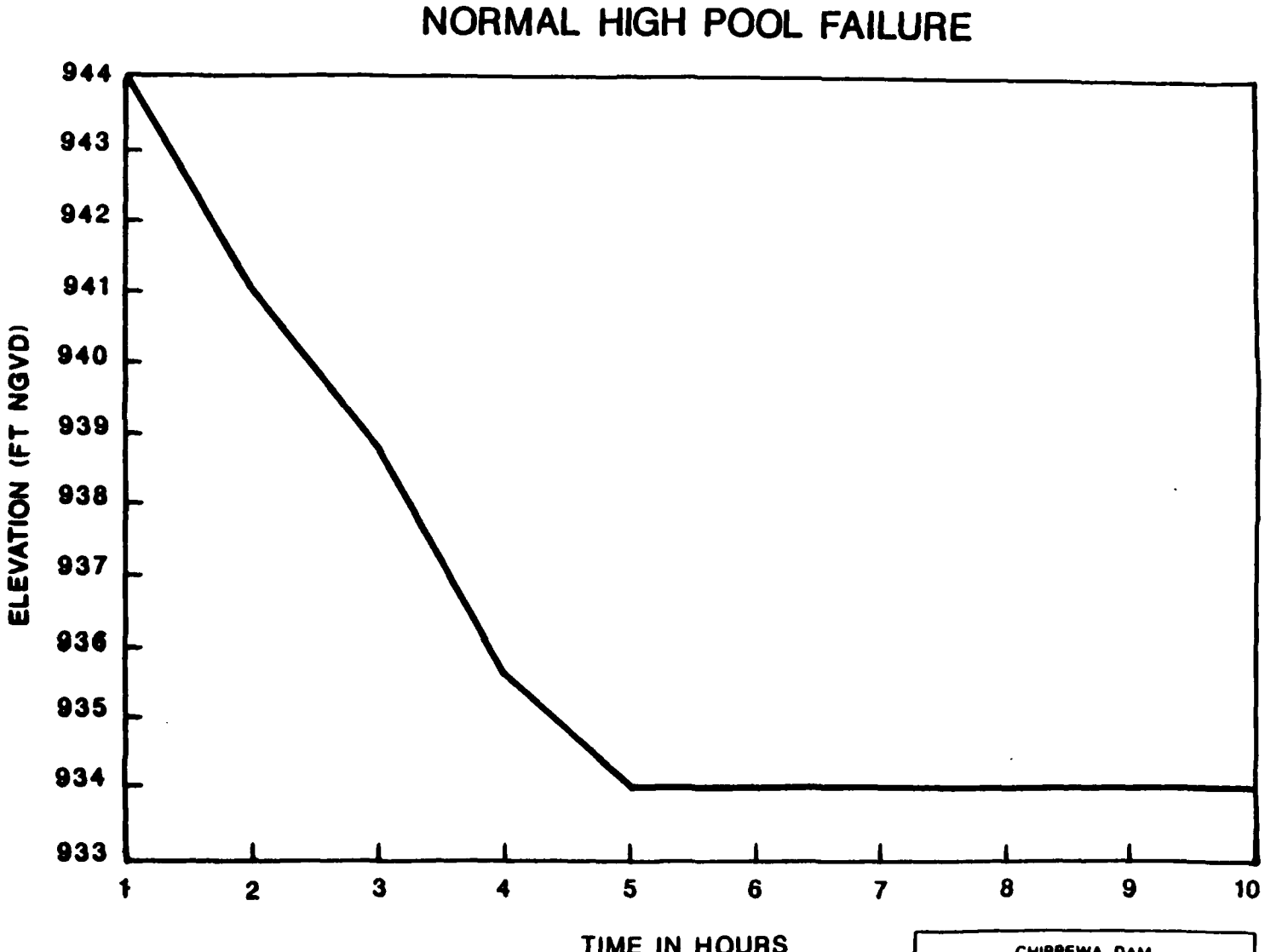



CHIPPEWA DAM

NORMAL HIGH POOL FAILURE

ST. PAUL DISTRICT
U.S. ARMY CORPS OF ENGINEERS

PLATE F-1




CHIPPEWA DAM

NORMAL HIGH POOL FAILURE

ST. PAUL DISTRICT
U.S. ARMY CORPS OF ENGINEERS

PLATE F-